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SURVEY OF INDIA

GENERAL REPORT

1926 TO 1927



**From 1st October 1926
To 30th September 1927**

**PUBLISHED BY ORDER OF
Colonel Commandant E. A. TANDY, R.E.,
SURVEYOR GENERAL OF INDIA.**

**Printed at the Photo.-Litho. Office,
Survey of India,
CALCUTTA,
1927.**

PREFACE.

THE WORK OF THE SURVEY OF INDIA.

The department is primarily responsible for all topographical surveys and explorations, and for the maintenance of geographical maps of the greater part of Southern Asia. Also for geodetic work, which includes:—the main trigonometrical framework, extending in some cases far beyond the frontiers of India, and control networks of precise levelling based on tidal observatories; tidal predictions and the publication of Tide Tables for nearly 40 ports between Suez and Singapore; the Magnetic Survey; astronomical, seismographic, and meteorological observatories at Dehra Dūn; and geodetic investigations of an international character, in regard to which India enjoys a unique position between the greatest highlands of the world and a deep ocean extending to the Antarctic. Indian geodesy has thus disclosed by far the largest known anomalies of gravitational attraction in the earth's crust, and these have led to some of the most important developments of modern geodetic research, whilst the Great Trigonometrical Survey of India enjoys an international reputation as a very valuable contribution to estimates of the size and figure of the earth. The calculations of astronomy and some important data in physics depend ultimately on these terrestrial measurements.

In the past the department has also carried out the original large-scale revenue surveys for most of India, and was still conducting this work for Central and Eastern India and Burma up to 1905, when all revenue surveys were handed over to the Provinces concerned, together with officers and staff as required, in order to concentrate the energies of the department on a complete new series of modern topographical maps on the scale of 1 inch to 1 mile. It was hoped to complete this series by 1930, but owing to retrenchment and the war little more than half has been done up to date, in spite of the reduction of the scale of survey for less important areas. Thus, although new surveys covering an area about equal to that of England are carried out every year, the maps of half the country are still very old and only kept up to date roughly by means of rather perfunctory information supplied by local officials; the old maps are also about 2 miles out of position, being based on a longitude of Madras determined in 1815.

Boundary surveys and records of international, state, and provincial frontiers have always formed an important item of topographical work; and in recent years there has been considerable progress in the preparation of Guide Maps for important cities and military stations, where the one-inch scale is quite inadequate.

(

Miscellaneous. While expending on topographical and geodetic work all funds allotted by Imperial Revenues, the department is steadily developing the policy of aiding local surveys in various ways, on payment by those concerned. These miscellaneous operations include: all forest and cantonment surveys: many riverain, irrigation, railway, and city surveys, and surveys of tea gardens, mining areas, &c., with a great deal of control levelling for the same; administrative assistance and officers are also given in aid of the revenue surveys of various Provinces and States. The Printing offices do much work for other Government departments, such as printing special maps, illustrations for Archeological Reports, all diagrams for Patents, &c. The Mathematical Instrument Office gives valuable aid to all Government departments by ensuring a high standard of instrumental equipment, especially in connection with optical work and by the manufacture and repair of high-class instruments which would otherwise have to be imported from abroad.

Military, &c. The department is also responsible for all survey operations required by the Army, and has been rapidly developing measures to meet the greatly increased complexity of modern military requirements, especially in connection with air survey. In view of its high military importance, air survey work for various civil purposes is receiving all possible encouragement and assistance, while the latest methods of stereo-photography are being studied experimentally.

Administration is by the Surveyor General under the Education, Health and Lands Department of the Government of India. The Headquarters Office is at Calcutta under the Assistant Surveyor General, and there are seven Directors, one for each of the five Survey Circles into which the country is divided, one for the Geodetic Branch at Dehra Dūn, and one for the Map Publication and other technical offices at Calcutta.

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SURVEY OF INDIA

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INTRODUCTION AND SUMMARY.

1. Annual Reports.—Annual Reports are now published in three separate volumes as follows:—

General Report.

Geodetic Report.

Map Publication and Office Work Report.

The first two are for the survey year ending 30th September but the last is for the financial year up to 31st March.

The Map Publication Report contains *all the index maps* showing the progress of map publication on all scales, with reports on publication and issues, printing and drawing, and of such offices as the Mathematical Instrument Office, which have to conform with the financial year.

The Geodetic Report includes full details of all scientific work.

This General Report only gives brief abstracts of the above (*vide* Abstracts II and III in the Table of Contents) but gives complete reports of the survey operations of the ordinary field parties and detachments. Abstracts I and IV (*vide* Table of Contents) summarise these latter reports and enable the reader to look up such portions as may concern him. There is one index map at the end, showing the progress of modern topographical surveys and compilation. Maps of sorts are of course available for all parts of the Indian Empire, but some are very old, and all previous to 1905 were based on the old longitude of 1815, (which was over 2 miles out), and are excluded from the index map.

2. General. Colonel Commandant E. A. Tandy, R.E., returned from leave and took over the post of Surveyor General from Colonel C. P. Gunter, O.B.E., R.E., on the 19th November 1926.

The post of Assistant Surveyor General was filled by Major C. M. Thompson, I.A., up to 14th April 1927, and afterwards by Major W. E. Perry, M.C., R.E.

3. *The total cost of the Department for the past financial year ending 31st March 1927, as compared with that of previous years, was as follows:—*

	1924-25	1925-26	1926-27	REMARKS.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>	
Gross actual cost ...	58,66,784	5 64,11,135	56,65,658*	The increase in net charges is chiefly due to changes in accounting and purchase of buildings, etc.
Deduct receipts and credits	22,27,138	21,60,926	23,20,585*	
Net actual charges ...	31,39,646	32,50,209	33,45,073*	

*These figures are not final.

The total area of new surveys of all kinds completed during the year was 58,210 square miles (p. 24).

4. *Organization.* The whole area of India and Burma is divided for the purposes of the Survey of India into five Circles. The limits of these are shown by blue lines on the index map at the end of the book. In order that civil administrations and the public may know which Director to address on survey matters a list of Provinces and States comprised in each Circle is given in the loose slip containing Survey Notices.

The designation of Officer-in-charge of the Mathematical Instrument Office, Calcutta, has been changed to 'Superintendent' and those of the Works Manager and the Assistant Manager of the office have been changed to 'Assistant Superintendents'. All these three posts are now of gazetted status.

A most interesting Survey Museum has been started in the Geodetic Branch Office at Dehra Dūn, and better accommodation has also been provided for the Training School; this centre has now become an excellent place for young officers of all ranks to get a good impression of our records and traditions during the past century, when they report here for their first training.

As neither *A* nor *E* Company of the Frontier Circle recess at the Circle headquarters it was found necessary to form permanent drawing sections in both these companies from 1926 to help their fair mapping and make the units more complete.

Reproducing Sections were formed in October 1926 with *E* Company at Quetta and with No. 18 P^rty at Peshāwar to meet the local demand

for reproduction work and to increase the power of mobilisation of *A* and *E* Companies.

No. 24 (Sind Rectangulation) Party was formed from 1st October 1926, under the administration of the Frontier Circle, to undertake the Rectangular Survey of the Lloyd Barrage area (Sind) for the Bombay Government.

5. Notable events of the survey year were as follows:—

The first modern Survey of Nepāl, commenced in 1924, was completed in March 1927. A brief account of the work will be found in Appendix II of this Report and the main geographical results are shown in the Frontispiece.

Turco-Irāq Boundary Commission. The Survey, including photo-survey with the Wild photo-theodolite lent by the Royal Geographical Society, was carried out by a Survey of India detachment during the summer of 1927. This consisted of Major Lewis, R.E., in charge, with Mr. Muhammad Hasan, Sub-Assistant Superintendent, five surveyors and twenty-eight khalasis.

North West Frontier Province. Topographical surveys were completed of the hitherto closed areas of Swāt and Dīr, and further extensions of work in this important neighbourhood are in hand (pp. 36).

Exploration. The expedition under Major Mason, which set out in April 1926 to explore the Shaksgam Valley and Aghil ranges, beyond the Karakoram, closed work in October 1926 and returned in November (pp. 86).

Surveyor Torabaz Khan was deputed to accompany the exploring party of Mr. H. F. Montagnier of the Alpine Club with a view to connecting the work of the Visser expedition of 1925 to that of Major Mason noted above (p. 88).

The fundamental longitude of India was re-determined by the Dehra Dūn Observatory as part of an international scheme for the determination of precise longitudes, in which 40 leading observatories of the world took part. The result is in close agreement with that reached by very laborious operations over 30 years ago (p. 11).

Geodetic Congress. Lt.-Colonels M. O'C. Tandy and R. H. Thomas represented the Survey of India at the Third Congress of the International Union of Geodesy and Geophysics held at Praha (Prague) from 30th August to 10th September 1927.

Twenty-three countries, represented by 195 delegates, attended the Congress. Dr. Bowie, Director of the Coast and Geodetic Survey, U. S. A., as President of the Section of Geodesy, eulogised the past

work of the Survey of India, remarked on the great international importance of its work, and expressed the interest which all geodesists would take in its future operations.

Considerable interest was expressed in the recent investigations by Dr. de Graaff Hunter regarding the Figure of the Earth.

An Air-Survey Committee consisting of officers of the Royal Air Force, General Staff and Survey of India, and the Director of Civil Aviation, has been formed to collect information and to watch developments in air-survey, both civil and military, in all parts of the world and to act as advisers to the Government of India, Local Governments and Indian States, on all questions connected with air-survey. The first meeting of the Committee was held at Delhi in March, 1927.

An F.8 Air-Photo Camera has been purchased for use in Air-Surveys.

Manœuvres. A Survey Section from *E* Survey Company was attached to the Western Command Manœuvres, 1926. A Section from *A* Survey Company was attached to the Tactical Exercise of Northern Command 1926 to co-operate with a Royal Artillery Survey Section.

Adventures and Casualties. Burmese dacoits near the Siam frontier attacked a party of four khalasis, who were in charge of money, killing two and very seriously wounding the other two. The Burma parties (Nos. 10 and 11) lost fifteen men from cholera, while a khalasi of No 10 Party was killed by a wild elephant and a mule-driver in 11 Party by a tiger. Work in the Eastern Circle was occasionally enlivened by wild elephants and tigers, and in No. 1 Party's area man-eating tigers were a serious menace, fourteen villagers being killed by them during the period of survey.

New buildings. The Bonnie Brae Estate in Shillong has been purchased for offices for the Eastern Circle. The building vacated by the office of the Controller of Military Accounts in Quetta was purchased from the Army Department as an office for *E* Survey Company (Frontier Circle).

Officers on leave have done much useful work in studying modern developments of various kinds. Lt.-Colonel Hamilton, and Majors Mason, Slater and Jackson were deputed, while on leave at home, to visit Government offices and firms in England, France, and Switzerland, in order to study the latest improvements and processes in photogrammetric, stereographic and air survey, as well as modern methods of reproduction and other matters at the Ordnance Survey, Southampton. Lt.-Colonel Hamilton also investigated Artillery Survey developments at Larkhil

and attended the combined Naval, Military and Air Force Survey Exercise in Scotland, and has supplied very full and valuable reports on all the above.

Major Meade underwent a course of instruction in air-photo survey at the School of Photography, Farnborough, and produced a very good report illustrated by diagrams and photographs.

Major Lewis was employed by the High Commissioner in England on work connected with the revision of maps for the *Imperial Gazetteer of India*, and Captain Glennie completed the standardization of the four half-second pendulums.

Messrs S. Colquhoun and C. F. Oddy, Managers, Photo. Litho. Office, also visited certain firms in England and Scotland and the Ordnance Survey Office, Southampton, to gain experience of the latest developments in map reproduction.

6. Appreciations.—Major Lewis has received the following appreciation of the work of his party on the Turco-Iraq Boundary Commission from the acting Prime Minister of Iraq:—

“On the completion of the work of the Frontier Delimitation Commission I have great pleasure in asking you to accept my warmest thanks and congratulations for the excellent work performed by you and your party.”

“The Iraq Government desire to express to you their appreciation of the remarkable services which you have rendered to Iraq.”

The Assistant Commissioner, in charge of the Mysore—South Kanara Boundary Settlement in 1924-25, in his Report to the Madras Government has made special reference to the good work of Mr. V. W. Morton and surveyor Mokham Chand when nearly all the survey staff were down with malaria and had to face special difficulties.

In the Annual Report for the year ending 31st July 1926, Mr. R. M. Crofton, I.C.S., the Settlement Officer, Melghāt Settlement operations in the Central Provinces, has expressed his high appreciation of the traverse work conducted by Mr. N. N. Chukerbutty in a remote and difficult tract.

Sir Aurel Stein, K.C.I.E., Ph.D., D.Litt., D.Sc., has expressed his keen appreciation of the valuable services rendered by Mr. A. T. Brendish who accompanied him as photographic assistant in his recent explorations in Baluchistān. He has also specially commended the excellent work done by Surveyor Torabaz Khan who accompanied him in his expedition to the Upper Swāt Valley in 1926, and has placed on record his appreciation of the remarkable zeal, energy and skill displayed by

this surveyor in the execution of his work. Mr. H. F. Montagnier, with whom Torabaz Khan was exploring this year, has also written in high praise of his work.

7. Awards.—His Majesty the King approved the award of the Founder's Medal of the Royal Geographical Society to Major Kenneth Mason, M.C., R.E., for his connection between the surveys of India and Russian Turkistān through the Pāmirs in 1913, and his organization and conduct of the Shaksgam Expedition of 1926.

The Governor General in Council was pleased to sanction the grant of the *Indian Distinguished Service Medal*, to Surveyor Mir Abdullah, Survey of India, attached Air Headquarters, 'Irāq, for distinguished service, exceptional zeal and devotion to duty in survey work, while serving with military columns operating in 'Irāq and Kurdistān during 1926.

The Arthur Holiott Garrett Prize for 1926 was awarded by the Council of the Institution of Royal Engineers to Captain G. F. Heaney, R.E., for his essay "Survey on Active Service."

His Excellency the Governor General of India has been pleased to confer the Volunteer Officers' Decoration upon Mr. B. T. Wyatt who is a Lieutenant in the Bangalore Battalion of the Auxiliary Force.

8. Personnel.—Casualties, retirements, and recruitments were as follows:—

Class I Officers:—Mr. J. O'B. Donaghey died. Mr. H. W. Biggie retired.

Mr. B. M. Berrill was confirmed as Superintendent, Captain G. W. Gemmell, I.A., and Lieuts. D. M. Burn, R.E., and I. H. R. Wilson, R.E. were appointed to the Department.

Messrs H. P. D. Morton, P. A. T. Kenny, O.B.E., and Major J. H. Williams from Class II were promoted to fill temporary posts in Class I Service.

Class II Officers:—Mr. E. C. O'Sullivan, D.C.M., died while on foreign service in 'Irāq. A competitive examination for the recruitment of 7 probationers to the Class II Service was held at the various Survey headquarters in September; 72 candidates were nominated to sit for examination by the Selection Boards.

Upper Subordinate Officers:—Mr. B. Batabyal died. Four Lower Subordinates were promoted to the Upper Subordinate Service and fourteen probationers were appointed in October 1926, of whom four have resigned.

I.—ABSTRACT OF SURVEYS IN EACH PROVINCE AND STATE.

9. The annual expenditure of surveys in the Indian Empire must amount to something like three crores of rupees, or say two million pounds, if we include cadastral surveys, carried out locally by Provinces and States, and miscellaneous surveys for engineering projects, *e.g.*, railways, canals, mines, roads, rivers, harbours, cities, &c.

The prime duties of the Survey of India are geodetic, topographical and geographical, and cost little more than a tenth of this total (about Rs. 33,00,000); but the department is also developing co-operation with local survey agencies, with a view to mutual economy, and is now doing miscellaneous outside work costing nearly Rs. 30,00,000, on payment by those concerned, besides advising and co-operating in other directions and lending officers to Provincial Surveys as required. The following abstract shows the nature and *locale* of the field operations actually carried out by the Department during the past year, grouped under the following sub-heads:—

Air Surveys.	Riverain Surveys.
Exploration.	Boundary Surveys.
Topographical Surveys.	Geodetic.
Forest Surveys.	Framework.
Cantonment and City Surveys.	Levelling.
Cadastral Surveys.	Miscellaneous.
Railway Surveys.	Training.

10. N. W. F. Province and Kashmīr.

Exploration in Shaksgam Valley, Aghil Range, Kashmīr State (p. 86) and in Hunza State (p. 88).

Topographical surveys in Dir, Swāt and Chitrāl, Khyber Agencies, Tribal territories and Peshāwar district (p. 37).

Forest surveys in Hazāra Division (p. 37).

Cadastral and boundary surveys in Peshāwar district (p. 48).

Framework, triangulation in Dir, Swāt and Chitrāl (p. 37); in Kashmīr State (p. 37). Traverse and triangulation in Peshāwar district for Settlement Surveys (p. 48).

Miscellaneous, Upper Bāri Doāb Canal survey, Kashmīr State (pp. 56, 57).

11. Baluchistān.

Topographical surveys in Las Bela State (p. 40).

Cantonment survey of Fort Sandeman (p. 33).

12. Punjab, Punjab States and Delhi.

Air surveys in Multān district (p. 41).

Topographical surveys in Rāwalpinḍi district (p. 37); and in Multān, Muzaffargarh, Jhang and Lyallpur districts (p. 56).

Cantonment and City surveys at Amritsar, Lahore and Multān (p. 83).

Riverain surveys in Lyallpur, Montgomery & Shekhūpura districts (p. 56).

Boundary surveys in Dera Ghāzi Khān district & Bahāwalpur State (p. 57).

Framework in Lyallpur and Montgomery districts (p. 56); in Gurdāspur and Kāngra districts (p. 56). Rectangulation in Multān, Muzaffargarh, Jhang and Lyallpur districts, (p. 56).

Levelling, one line of geodetic levelling Amritsar-Wazīrābād (p. 15); seven lines of secondary levelling and a large amount of tertiary levelling for the Haveli Project (p. 85).

Miscellaneous, Upper Bāri Doāb Canal survey in Gurdāspur and Kāngra districts (p. 56, 57).

13. Rājputāna Agency, Ajmer and Bikaner. Nil.**14. Central India Agency and Gwalior.**

Topographical surveys in Bundelkhand Agency, Nowgong and the States of Orchhā, Pannā, Chhatarpur, Charkhārī, Bijāwar, Alipura Garrauli and Tori-Fatehpur; Bihat, Naigawān Rebai, Dhurwai and Bijnā Jāgirs (p. 59).

15. United Provinces.

Topographical surveys in Jhānsi and Hamīrpur districts (p. 59).

Forest surveys in Bāndā and Jhānsi Forest Divisions (p. 60).

Cantonment and City surveys, traversing of Benares City Municipal area (pp. 52, 53).

Levelling, three lines of geodetic work, i.e., Muttra-Cawnpore, Cawnpore-Benares and Dehra Dūn-Mussoorie and one of secondary work (p. 15).

16. Central Provinces.

Topographical surveys in Surgujā State and the Bālāghāt Bhandāra, Chānda, Nāgpur, Wardhā and Damoh districts (pp. 52, 54, 62).

Framework in Jashpur and Surgujā States (p. 53). Bālāghāt, Bhandāra, and Drug districts (p. 55).

17. Bombay Presidency, States of W. India and Baroda.

Topographical surveys in Hyderābād and Karāchi districts of Sind (p. 40).

Forest surveys in west Nasik Division (p. 66).

Cantonment and City surveys of Karāchi and environs (p. 39).

Framework, triangulation and traverse for topographical surveys in Hyderābād and Karāchi districts of Sind (p. 40). Rectangulation and traversing in Lārkāna and Nawābshāh districts of Sind (p. 47).

Levelling, four lines of geodetic work *i.e.*, Surat-Dhūlia, Porbandar-Rājkot, Tatta-Mughalbhīn and Hyderābād-Sukkur (p. 15).

18. Hyderābād.

Topographical surveys in Adilābād, Karimnagar, Aurungābād, Secunderābād and Bolārum (p. 62); in Raichūr district (p. 64).

Miscellaneous, large-scale surveys of the Ellora and Ajanta Caves (p. 62).

19. Mysore and Coorg.

Topographical surveys in Tumkūr and Chitaldrug districts (p. 64).
Mysore district (p. 66).

Framework, triangulation in the neighbourhood of Hoskote near Bangalore for the Royal Artillery (p. 64).

Miscellaneous, large-scale surveys of private tea and coffee estates in Kadūr district (p. 64).

20. Madras Presidency and Madras States.

Topographical surveys in Anantapur, Bellary and Kurnool districts and Sandūr State (p. 64); in Coimbatore, Nilgiri, Salem and Trichinopoly districts (p. 66).

Miscellaneous, large-scale surveys of private estates in the Coimbatore district (p. 66); in the Kottayam and Devikolam districts of Travancore State (p. 66).

21. Bihar and Orissa.

Topographical surveys in Hazāribāgh, Palāmau, Rānchi, Mānbhūm, Santāl Parganas and Singhbhūm districts; in Keonjhar and Mayūrbhanj States (pp. 52, 70, 71, 72).

Forest surveys, Palāmau and Chaibāsa Forest Divisions (p. 52), State forests of Mayūrbhanj (p. 72).

Framework in Hazāribāgh, Palāmau, Mānbhūm, Rānchi, Balasore and Cuttack districts; in Keonjhar, Mayūrbhanj and Nilgiri States (pp. 52, 53, 70, 72).

Levelling in Mānbhūm district (p. 71).

22. Bengal Presidency and Sikkim.

Air survey in Chittagong district for Settlement surveys (pp. 41-43).

Topographical surveys in Bānkurā, Burdwān, and Midnapore districts (pp. 70, 72).

City surveys in Calcutta City (p. 73).

Framework in Bānkurā, Jalpaiguri and Rangpur districts and Cooch Behār State (p. 70).

Levelling, six lines of secondary levelling for the Calcutta Port Trust and Bengal Government (p. 84). Minor levelling in the Bānkurā district (p. 71).

23. Assam and Bhūtān.

Topographical surveys in Goālpāra, Kāmṛūp, Khāsi and Jaintiā Hills and Gāro Hills districts (p. 73).

Forest surveys in Goālpāra, Kāmṛūp and Gāro Hills Forest Divisions (p. 74).

Framework in Goālpāra and Gāro Hills districts (p. 73).

24. Burma, Andamans and Nicobars.

Topographical surveys in Bassein and Myaungmya districts (p. 75); Salween, Thaton and Toungoo districts (p. 78).

Forest surveys in Delta Forest Division (pp. 75, 76); Thaton and Salween Forest Divisions (p. 78); Magwe, Meiktila, Prome, Yamethin and Mu Forest Divisions (pp. 80, 81).

Cantonment and City surveys of Maymyo and environs (p. 79).

Framework, Principal triangulation from the Burma Coast Series southwards to a point 20 miles south-west of Rangoon. Minor traverse by topographical parties in Bassein, Hanthawaddy Ma-ubin, Myaungmya and Pyapon districts (p. 76); triangulation and traverse in Insein, Pegu and Thaton districts (p. 79).

Levelling, two lines of secondary levelling for the Burma Government (p. 85).

25. Transfrontier.

Topographical surveys of Nepāl (p. 92).

II.—ABSTRACT OF GEODETIC OPERATIONS.

DIRECTOR:— | Lt.-Colonel M. O'C. Tandy, D.S.O., O.B.E., R.E., up to 30-6-27.
| Dr. J. de Graaff Hunter, Sc.D., M.A., F.Inst.P., from 1-7-27.

26. General.—Besides geodetic work, the Director, Geodetic Branch administers the following offices at Dehra Dūn; *No. 2 Drawing Office*, the *Forest and Cantonment Office* and the *Publication and Stores Office*, whose work is reported in the annual Map Publication and Office-work Report; also the following Survey operations which are reported in other parts of this General Report:—*Commercial levelling* (i.e. levelling carried out in aid of special engineering projects and paid for by those concerned, *vide* para. 33 below); *Cantonment Surveys* (para. 201); *Training School* (para. 208). In addition the Director has been charged with the general administration of the *Nepāl Survey* during the past three years (Appendix II), with the *Bhopāl Detachment* from 1st December, 1925 to 31st March 1927, and with the *Shaksgam Expedition* (para. 209).

27. Geodetic.—Purely geodetic operations include miscellaneous computations and research, preparation and publication of records, observatory work (astronomical, magnetic, seismological and meteorological); important series of triangulation, geodetic levelling, precise latitudes, longitudes, azimuths, and gravity determinations, in all parts of India; and prediction of the Tides at 38 Eastern ports between Suez and Singapore.

These geodetic operations are fully described in the *Annual Geodetic Reports of the Survey of India*. The full reports have fallen into arrears since 1922, during the changes in the system of annual reports (*vide* Appendix I), but there is now at press a combined Geodetic Report for the years 1922-25, and separate Reports for the year 1925-26 and for the current year 1926-27. The following is a brief abstract of the geodetic operations described in the Geodetic Report for the current year, which includes complete Index maps and detailed results.

Geodetic Operations for 1926-27.

28. Observatory Section.—*International Longitude*—The most important geodetic operation of the year has been the determination of the basic longitude of India, as part of an international project in which 40 of the leading observatories of the world took part. The project was put forward in 1924 by General Ferrié, President of the

International Longitude Commission, for the simultaneous determination of longitudes by means of radio time-signals. This project was developed and finally given effect to, in October and November, 1926. From 1924 onwards preparations were made at Dehra Dūn for the work. These included the building of a small observatory, and the purchase of a clock of the highest precision, which had to be installed in a special room in which the temperature is automatically maintained constant. A radio receiving set, capable of picking up long-wave time-signals, was obtained, and other additions were made to existing equipment. These preparations were made by Dr. J. de Graaff Hunter, who also had charge of the final operations. At various observatories, the relative differences of local time of the receipt of the world time-signals, attained with the highest possible precision give the relative longitudes. For the attainment of this precision two transit instruments and one prismatic astrolabe were employed. Observations extending from 9 P.M. to 3 A.M. were made on nearly all nights from 1st October to 30th November. The time signals sent out by Bordeaux and Saigon were received both by day and by night. In this arduous programme six observers took part: Captain G. H. Osmaston, M.C., R.E., Captain G. Bomford, R.E., Lieut. H. W. Wright, R.E., Lieut. I. M. Cadell, R.E., Mr. B. L. Gulatee, B.A., and Mr. R. B. Mathur, B.A.

The final value of the longitude will be derived when all available observations of the various participating observatories have been considered as a whole. The provisional result already obtained shows the longitude of Dehra Dūn to be 0·02 seconds of time more easterly than the value obtained in 1894-96 by Colonel Sir Sidney Burrard, K.C.S.I., R.E., F.R.S., and Colonel Sir Gerald Lenox-Conyngham, Kt., R.E., F.R.S., by the older method of wire telegraphy.* It is anticipated that the recently determined value will not be changed by more than one hundredth of a second when the final reduction is complete. The evidence, so far as

*This telegraphic determination took these officers two years to accomplish (1894—1896) as longitude differences had to be separately measured between Greenwich, Potsdam, Tehrān, Būshire, Jāsk and Karāchi, and line-clear was necessary on the public telegraphic lines at pre-arranged times on several nights for each section, while extreme patience and accuracy were required to secure good results. Wireless methods have now enabled us to get an international determination of greater certainty at a comparatively trifling cost, but it is very satisfactory to the Department, and must be a source of gratification to the two officers concerned, to find the results of their labours of over 80 years ago confirmed within about one-fiftieth of a second in time, which corresponds with an actual difference of less than 10 yards in the relative positions of Greenwich and India.

it goes, indicates that during the last 30 years there has been no measurable change in the longitude of India of the type involved in Professor Wegener's hypothesis.

Magnetic and meteorological observations were taken as usual at Dehra Dūn throughout the year. Several magnetic storms were recorded, those occurring on 14th to 16th October 1926, and 14th to 16th April 1927 being of very great intensity. The second of these coincided with the earthquake in Japan on 16th April 1927. The Omori Seismograph recorded 25 earthquakes during the year, of which 2 were major and 23 minor. The Haig Observatory is being rebuilt and will be used as a regular latitude observatory. When it is completed, the Tide Predicting Machine and the Omori Seismograph will be installed in it.

Miscellaneous.—The periodical comparisons against the Standard Bar I, of tapes used by the high precision spirit-levelling detachments of No. 17 Party are now made by the Observatory Section. The base-line comparator is used for this work. A growing interest in the working of the scientific instruments of the Dehra Office has been evident from the greater number of visitors to the observatories during the year.

29. Computing Section.—At the request of Professor Wegener, the results of latitude observations at stations in India, occupied at long intervals of time, up to 70 years, were scrutinized. Our conclusion is that no appreciable movements of the earth's crust have occurred in India since 1800, either northwards or southwards. Graphical adjustment of topographical triangulation on a large scale was done for the Director, Frontier Circle. Numerous computations for star charts, astrolable reductions in connection with the International Wireless Longitude operations, aneroid heights for Sir Aurel Stein's work in the Pāmirs, and remodelling of professional forms were carried out. 50 degree-sheet triangulation pamphlets (including some of the Mesopotamia triangulation) were compiled or recompiled.

Part III, Auxiliary Tables, which is in course of reprinting, has been further supplemented by star charts on the stereographic projection, for latitudes 30° and 15° . The Geodetic Report covering a period of 3 years 1922-25, the first volume of a new series of publications, and also the second volume 1925-26, have been edited.

30. Tidal Section.—Since 1921 India has taken over tidal predictions for 38 ports between Suez and Singapore. This has led to a considerable economy. Certain modifications in prediction have been introduced and mechanical additions have been made to the tide-predict-

ing machine, whereby the predicted times of high and low water are registered electrically on a separate sheet. The curves representing the height of water at any time can accordingly be run off on a much reduced time-scale, which is a practical convenience.

Tidal registrations were carried out by means of self-registering tide-gauges at Aden, Basrah, Bombay, Karāchi, Madras, Kidderpore, Rangoon, Bassein and Deserter's Creek (Rangoon River).

In addition to the above, the readings of the actual times and heights of high and low water, taken on tide-poles during daylight only, were continued at Bhāvnagar, Chittagong and Akyab under the orders of the Port Officers concerned, who forwarded the results monthly. Weekly charts of the tidal curves registered on the automatic tide recorder at Ma'qil continued to be received from Basrah for each month. The observations for the year 1924 at Bassein have been reduced by the method of harmonic analysis.

The printing and publication of the 1928 Tide Tables for Indian ports is expected to be completed by about the end of October, 1927. Advance printed copies of the Tide Tables for 17 ports for 1928 were despatched to the Hydrographer to the Admiralty by the end of March, 1927.

During the year the tidal observatories at Bassein and Rangoon were inspected. A new tide-gauge was installed at Deserter's Creek (Elephant Point, Rangoon River) and tidal registrations were started from the 20th March, 1927.

31. Gravity and Deflections.—(Nos. 13 and 14 Parties)—No field work was undertaken, but the Hayford reductions of the stations observed at in Kashmir in 1925 were carried out. The personnel were occupied with the longitude work referred to in para. 28 above, and with other researches, including levelling across wide rivers (*vide* para. 32).

32. High Precision levelling.—(No. 17 Party)—The work reported in this paragraph is levelling of the highest possible accuracy. It forms part of the second geodetic level net of India, which was commenced in 1920. As projected it consisted of 13,300 miles of levelling, to which 908 miles have since been added. 4,800 miles have now been completed. During 1926-1927, 1,271 miles of single levelling were carried out as below, which are equivalent to 524 miles of completed work.

In fore direction only.--

Bombay.—Tatta to Mughalbhin, 66 miles.

Punjab.—Amritsar to Wazirābād, 105 miles.

In back direction only.--

Bombay.—Dhūlia to Surat, 152 miles.

United Provinces.—Muttra to Cawnpore, 237 miles.

United Provinces.—Cawnpore to Benares, 220 miles.

In both directions.--

States of Western India.—Porbandar to Rājkot, 268 miles.

Revision.--

(h) *Sind.*—Part of Hyderābād to Sukkur, 183 miles.

Refraction correction.—It has long been considered possible that lines of levelling along persistent slopes may have a systematic error due to refraction. The line from Dehra Dūn (2,200 feet) to Mussoorie (6,500 feet) was considered a rather extreme case, and an estimate was made in 1910 of the possible amount of error resulting from this cause. In the present year the line has been relevelled in both directions, and the necessary temperature readings have been taken to enable the refraction to be computed. The result found is that a correction of +0.03 feet should be applied to the height of Mussoorie above Dehra, which is about one third of that arrived at in 1910 using estimated temperatures.

This appears to show that a refraction correction is not ordinarily worth considering.

Levelling across rivers.—An enquiry into the most precise method of carrying spirit-levelled heights across wide rivers has been made. Field experiments were carried out and useful practical deductions have been made regarding the best method to employ and the precision that will be obtained thereby.

33. Commercial levelling.—Details of secondary and tertiary levelling for various engineering projects also carried out by No. 17 Party are given in Part X of this report, paras. 206, 207.

34. Miscellaneous.—*Organization and Offices.*—In 1922 the Tidal Party was abolished and its work handed over to the Computing Party, while a new charge—the Publication and Stores Office—was formed in its place. This latter office includes the Photo-Zinco Office, the Letter-press Printing Office and the workshops and stores, and thus relieves geodetic officers of extraneous distractions, while providing for the closer supervision of these miscellaneous duties and enabling us to cope with the increased work due to our having taken over from England the responsibility for Tidal Predictions and the preparation of Tide Tables in 1922. As a result steady improve-

ments in efficiency and organization have become possible, and Lt.-Colonel M. O'C. Tandy, D.S.O., O.B.E., R.E., has brought these improvements to a head during his year and a half as director with very satisfactory results in all directions. Clerical and accounts duties have been re-distributed so as to clear up the previous confusion of responsibilities; the two map stores have been amalgamated and brought under the same roof with the Forest and Cantonment Office, and the building, hitherto used as a transit observatory and for helio-photography, has been altered to accommodate the training school, while the old steam engine which worked the printing presses is being replaced by an electric plant. The library and records have been brought into the main building with the Computing Office and a most interesting *Museum* of old geodetic instruments and records has been established near the library to illustrate various branches of the work as carried out during the past 100 years; this was opened to the public in March 1927, and has attracted many visitors. Meanwhile Dr. de Graaff Hunter, being relieved of petty distractions, has been able to effect marked improvements in observatory arrangements, especially in regard to Time observations and Tidal Predictions.

III.—ABSTRACT OF MAP PUBLICATION AND OFFICE WORK.

35. Full Reports of the work of all drawing, printing, and miscellaneous offices of the department, with *Index Maps* showing the progress and present state of map publication on various scales, have been published separately in the *Map Publication and Office Work Report* for the financial year ending 31st March 1927. The following extracts from the full Report show the most important result of all this work, in the shape of Publications and Issues, etc.

Table I (a)—Maps published at Calcutta, during the year 1926-27.

Class of maps.	Scale.	New publica- tions.	Reprints and new editions.	Number of sheets printed.	Value. Rs.
GENERAL MAPS.		<i>Departmental.</i>			
Maps of India	Various	1	3	14,690	19,885
GEOGRAPHICAL SERIES.					
Southern Asia	1:2,000,000	2	3	1,850	6,407
India and Adjacent Countries	1:1,000,000	5	44	23,550	43,844
Carte Internationale du Monde	1:1,000,000	3	4	2,550	7,650
TOPOGRAPHICAL SERIES.					
One-eighth inch, (Modern) ...	1"=8 miles	5	...	1,650	2,425
Quarter-inch, (Modern) ...	1"=4 miles	31	16	18,950	29,881
Do. (Prely.) ...	1"=4 miles	9	2	5,090	7,672
Do. (Provl.) ...	1"=4 miles	...	41	11,650	17,268
Half-inch, (Modern) ...	1"=2 miles	56	8	26,600	79,679
Do. (Prely.) ...	1"=2 miles	1	...	300	900
One-inch, (Modern) ...	1"=1 mile	142	106	123,333	188,999
Do. (Prely.) ...	1"=1 mile	18	3	7,600	11,387
Do. (Provl.) ...	1"=1 mile	...	1	200	300
Old style sheets ...	Various	...	28	6,675	10,818
SPECIAL MAPS.					
District maps ...	1"=4 miles	...	...	...	...
Administration report maps ...	1"=8 miles	...	...	...	...
Provincial maps ...	Various	3	6	4,220	14,928
Plans of Cities and Cantonments	Various	8	4	5,817	11,788
Index maps ...	Various	5	45	28,200	3,052
Miscellaneous maps ...	Various	27	16	20,390	13,449
Total ...	.....	316	330	298,315	468,732
		<i>Extra-departmental.</i>			
Maps ...	Various	140	46	159,574	35,094
Plans and diagrams ...	Various	326	6	258,888	18,480
Illustrations ...	.....	102	...	49,064	8,922
Miscellaneous ...	.....	80	38	248,275	8,307
Total ...	.....	648	85	710,301	70,753
Grand Total ...	.....	964	415	1,008,616	539,485

Table I (b)—Maps published at Dehra Dūn.

Class of maps.		Scale.	New publica- tions.	Reprints and new editions.	Number of sheets printed.	Value.		
		<i>Departmental.</i>				<i>Rs.</i>	<i>as.</i>	<i>p.</i>
Cantonment maps	...	Various	67	101	12,510	25,020	0	0
Forest maps	...	..	216	27	14,864	16,563	2	9
Miscellaneous	...	..	4	2	2,204	495	14	0
Total	...	...	287	130	29,078	42,079	0	9
		<i>Extra-departmental.</i>						
Maps	...	Various	103	6	20,883	7,456	10	7
Plans & diagrams	...	..	180	17	76,866	6,999	0	10
Charts	...	4" = 1 mile	606	...	69,664	11,099	0	0
Total	...	...	889	23	167,413	25,554	11	5
Grand Total	...	...	1,176	153	196,491	67,633	12	2

Table II—Abstract of modern topographical maps.

		One-inch sheets.	Half-inch sheets.	Quarter-inch Degree sheets.
Topographical maps published in 1926-27		142	56	31
Do.	do. published in previous years.	2,284	609	152
Total published		2,426	665	183
Number of sheets in India		6,218	1,630	450

Table III.—Letterpress publications.

(a) PUBLISHED AT CALCUTTA.

1. General Report of the Survey of India for 1925-26. (475 copies).
2. Map Publication and Office Work Report 1924-25. (475 copies).
3. Map Publication and Office Work Report 1925-26. (300 copies).
4. Supplement to the General Report 1924-25. (75 copies).
5. Supplement to the General Report 1925-26. (75 copies).
6. Hand-book of Topography, Chapter V, (1926). (600 copies).
7. Corrections to the Hand-book of Topography, Conventional Signs, Type-Tables, &c., (50,000 copies).
8. Symbols and abbreviations. (50 copies).
9. Tacheometer Survey Note book. (1,000 copies).
10. List of maps published, issued monthly. (800 copies).

Table III(a)—(Contd.).

11. List of F. O. U. O. maps, issued quarterly. (150 copies).
12. Survey Notes, issued monthly. (350 copies).
13. Government of India, Circular Orders, &c. (13,200 copies).
14. Distribution List of maps. (500 copies).
15. Distribution List of General Report. (50 copies).
16. Instructions for candidates for the Class II Service. (200 copies).
17. Instructions for candidates for the Upper Subordinate Service. (1,100 copies).
18. Annual Indents for European Stores. Various.
19. Calendar for 1927. (3,000 copies).

(b) In Hand at Calcutta on 1st April 1927.

1. *Hand-book of Topography, Chapter I, Revision of Appendix III.*
2. *Hand-book of Topography, Chapter VIII, Revised Edition.*
3. *Hand-book of Topography, Chapter XI, Revised Edition.*
4. *Corrections to the Hand-book of Topography.*
5. *Hand-book of Topography, Chapter IV, Addendum to —*
6. *Camp Officers' Record Book.*
7. *Index to names, Calcutta—Howrah guide map.*
8. *Photo.-Litho. Office Annual Indent of European Stores.*

(c) PUBLISHED AT DEHRA DŪN.

1. Records of the Survey of India. Volume XIX. The Magnetic Survey of India. (350 copies).
2. Records of the Survey of India. Volume XXI. (1) Air Survey in the Irrawaddy Delta.
(2) Report of the Bhutān and South Tibet Survey Detachment. (400 copies).
3. Professional Paper No. 20, Reconnaissance Survey from Aircraft. (350 copies).
4. *The Tide*, forming Part V of the Hand-book of Trigonometrical Instructions. (310 copies).
5. Auxilliary Tables, Part I. Fifth Edition, reprinted. (300 copies).
6. Levelling Pamphlet No. 44, Revised and extended. (300 copies).
7. Levelling Pamphlet No. 46, Addendum. (300 copies).
8. Triangulation Pamphlets (8). (100 copies of each).
9. Tide Tables, Indian Ports for 1927. (7,445 copies).
10. Theodolite Resection. (200 copies).
11. Reduction of Pendulum Observations—Addendum. (400 copies).
12. Traverse Tables. (500 copies).
13. Correction slips to Tide Tables. Auxiliary Tables, Levelling and Triangulation Pamphlets, &c. Various.
14. Lists of Bench-marks. (100 copies).
15. Circular Orders (Administrative) from January 1919 to December 1922. (450 copies).
16. Professional forms. (97,645 copies).
17. Miscellaneous jobs. (285,341 copies).
18. Calendar for 1927. (500 copies).

Table III—(Concl'd.).

(d) In Hand at Dehra Dūn on 1st April 1927.

1. *Geodetic Report 1922—25.*
2. *Report on Irrigation Surveys.*
3. *Hand-book of Topographical Instructions, Chapter IV—Theodolite Traversing (Revised Edition).*
4. *Hand-book of Topographical Instructions, Chapter VII; Addendum to —*
5. *Levelling—Part VI of the Hand-book of Trigonometrical Instructions (Revised Edition).*
6. *Levelling Pamphlet 41 J—Addendum to—*
7. *Levelling Pamphlet 73, Addendum to —*
8. *Secondary levelling sheet No. 85 P.*
9. *Triangulation Pamphlets (10).*
10. *Tide Tables, Indian Ports for 1928.*
11. *List of Cantonment and Military Stations in India (2 parts).*
12. *List of vernacular terms used in Survey of India maps.*
13. *Government of India Orders from January 1919 to December 1924.*
14. *List of periodical returns.*
15. *Circular by Surveyor General on Air Survey.*

36. Notes.—Calcutta.—In addition to the work shown in Table I(a) material was supplied for fair sheets of the Eastern and Burma Circles, and for the compiled fair sheets of all Circles, and also for the new Catalogue of Maps (under preparation) and for numerous extra-departmental maps, Nine indexes, in colours, for the General and Map Publication Reports and Supplement, were printed.

The work of surprinting the minute mesh on stock copies for the Army Department, which during the year involved several thousand sheets, is nearing completion.

37. Dehra Dūn.—In addition to the work shown in Table I(b) above, 62,972 prints of 1,011 originals, consisting of plane-table sections, triangulation charts and pamphlets, and forest maps were printed.

38. *The offices in regard to which full information is given in the Map Publication Report are:—The Seven Drawing Offices at the seven circle and branch headquarters; the Photo.-Litho., Map Record and Issue, and Mathematical Instrument Offices, Calcutta; the Publication and Stores and the Forest and Cantonment Offices, Dehra Dūn; and a few minor map printing establishments at other places.*

39. Map Issues.—Table IV.—Maps issued by Survey units.

		ON BOOK TRANSFER (TO GOVERNMENT OFFICIALS).		ON CASH PAYMENT.		FREE ISSUES.		TOTAL.	
		Number of copies.	Sale Value. Rs.	Number of copies.	Sale Value. Rs.	Number of copies.	Value. Rs.	Number of copies.	Sale Value. Rs.
D=Departmental									
X=Extra-departmental.									
Calcutta	D	87,790	91,307	101,463	1,06,943	59,879	94,654	249,132	1,98,250*
	X	702,173	63,790	26,142	17,028	3,538	840	731,853	80,818*
Dehra Dūn	D	14,517	24,306	2,132	5,956	6,808	12,520	23,457	30,262*
	X	75,916	12,297	46,466	9,097	66	115	122,448	21,394
Quetta ("E" Company)	X	.....	.....	1,407	909	.....	.....	1,407	909
Peshāwar (No. 18 Party)	X	...	.....	601	231	.....	.....	601	231
Mussoorie	D	.....	.....	290	474	.....	.....	290	474
Bangalore	D	151	287	2,882	5,601	.....	.....	3,033	5,888
Shillong	D	.....	.....	398	985	.....	.....	398	985
Maymyo	D	.....	.....	72	166	.....	.....	72	166
Totals	...	880,547	1,91,987	181,853	1,47,390	70,291	1,08,129	1,132,691	3,39,377

* These figures do not include the value of free issues.

40. Map Record and Issue Office, Calcutta.—Issues of departmental publications on book debit to Government Officials exceeded last year's figures by 26,443 copies; extra-departmental issues, on book debit, however, show a drop of 196,205 copies.

Cash sales and free issues of departmental publications increased by 37,594 and 30,328 copies respectively; extra-departmental cash sales fell by 42,840, while free issues showed a slight increase.

Steel almirahs with a total of 5,440 shelves (the figure 6,750 in last year's report was incorrect) have now been erected in the map store-rooms, at a total cost of Rs. 98,997.

These accomodate all the map sheets in modern style published up to date. Almirahs containing 5,860 shelves still remain to be constructed to provide storage for the complete Survey Programme.

41. Dehra Dūn Map Office.—The great bulk of the Issues from Dehra Dūn are Forest, Cantonment, and other special maps for other Government departments. During the year the separate Map Issue Offices of the Forest Map Office and No. 2 Drawing Office were amalgamated and brought under one roof.

42. Stock of Maps.—*Calcutta.* A comparison of Table I(a) with Table IV shows that whereas 1,008,616 sheets have been published at Calcutta during the year, only 986,786 sheets have been issued; therefore stocks in hand have increased by 21,830 sheets (316 new maps). The total stocks in hand in Calcutta are estimated at 5,000,000 sheets.

Dehra Dūn. The corresponding figures for Dehra Dūn are 196,491 published, 145,905 sheets issued; stocks in hand have increased by 50,586 sheets (287 new maps). The total stocks in hand in Dehra Dūn are estimated at 319,000 sheets.

43. Mathematical Instrument Office.—The demands on the office for the supply and repair of instruments and the workshop out-turn all show a considerable increase compared with recent years (*vide* 1, 2 and 6 in the following Table). Demands by Irrigation Departments and Railways were unusually high.

<i>Up to 31st March 1927.</i>	1924-25.	1925-26.	1926-27.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>
1. Total value of stores issued ...	3,75,024	4,20,340	5,17,410
2. Value of repairs carried out to order ...	1,28,931	1,34,008	1,40,144
3. Value of instruments, etc., returned to Store by those who no longer require them ...	51,875	51,045	99,369
4. <i>Book Value of Stock</i>			
(a) In Serviceable Store ...	3,25,685	2,55,474	2,48,669
(b) In Repairable Store ...	1,04,859	81,527	80,559
(c) In Material Store ...	2,25,449	2,16,136	1,94,132
5. <i>Value of New Instruments and Materials</i>			
(a) Manufactured in Workshops ...	1,42,616	1,75,874	2,40,642
(b) Purchased locally ...	35,356	43,326	83,016
(c) Imported through the Stores Department, London ...	95,750	92,003	1,82,919
6. <i>Workshops</i>			
(a) Value of work done ...	3,82,467	4,31,269	4,71,518
(b) Cost of employees (including pension contribution) ...	1,52,166	1,60,659	1,70,980
(c) Average number of employees ...	No. 386	No. 412	No. 458

IV.—ABSTRACT OF TOPOGRAPHICAL WORK.

44. The following Tables show the progress of the topographical programme assigned to the Department in 1905 and the out-turns and cost-rates of different parties during the year under report.

45. Progress. It was hoped in 1905 that maps on the scale of 1 inch to 1 mile would be available for the whole Indian Empire within 25 years; but the work has been greatly retrenched and delayed from various causes, and in 1913 the Secretary of State sanctioned a scheme for the reduction of the scale of survey in the less populous areas. Allowing for the surveys to be carried out on the reduced scales of $\frac{1}{2}$ inch and $\frac{1}{4}$ inch to 1 mile, under this scheme, we may roughly regard half the work as being completed by 1925; though there is a tendency to revert to the 1-inch scale in special cases owing to the pressing requirements of geologists and engineers, combined with the modern military view that this is the smallest scale suitable for tactical operations. Table B gives an idea of the work ahead according to present policy, and the state of the work is shown in the *Index Map* at the end of this volume.

Revision of modern surveys has also become necessary in some important frontier tracts and is already much needed in some other areas. Also some areas surveyed on smaller scales have had to be re-surveyed on a larger scale. The figures for this work are given in italics at the end of Table A.

Table A.—Progress of Topographical Surveys since 1905.

Scales of survey mostly 1 inch to 1 mile, but including a good deal of $\frac{1}{2}$ -inch work, and some $\frac{1}{4}$ -inch occasionally.

Survey years.	Old Northern Circle.	Old Southern Circle.	Old Eastern Circle.	TOTALS.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>
1905-10 ...	70,784	44,675	52,885	168,344
1910-15 ...	116,958	70,765	51,654	239,377
1915-20 ...	33,718	59,916	40,654	134,288
1920-25 ...	82,777	106,619	66,708	256,203
Totals to 1925 ...	304,232	281,975	211,896	798,207

Table A.—Continued.

The Burma Circle was separated from the Eastern Circle in 1922-23. The Northern and Southern Circles were reformed as three Circles in 1925-26. The above totals have therefore been redistributed amongst the present five Circles, as shown below:—

Survey years.	Frontier Circle.	Central Circle.	Southern Circle.	Eastern Circle.	Burma Circle.	TOTALS.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>
Up to 1925 ...	172,382	213,774	200,051	89,587	122,309*	798,103
1925-26 ...	4,906	11,621	14,187	6,029	6,012	42,705
1926-27 ...	7,964	6,036	13,753	10,889	5,543	44,185†
Up to 1927...	185,252	231,431	227,941	106,505	133,864	884,993†
<i>Balance re- maining.</i>	<i>346,363</i>	<i>206,569</i>	<i>115,609</i>	<i>178,730</i>	<i>132,011</i>	<i>979,282</i>
Total pro- gramme.	531,615	438,000	343,550	285,235	265,875	1,864,275†

Revision and Re-survey of the above work.

Up to 1926 ...	2,717	284	Nil	70	344	3,415
1926-27 ...	286	Nil	1,007	Nil	672	2,965

* These figures have been revised since last report.

† These totals are exclusive of the area surveyed in Nepal on the $\frac{1}{4}$ -inch scale. 14,025 sq. miles were surveyed in 1926-27, bringing the total for the Nepal Survey to 54,995 square miles.

Table B.—Analysis of balance remaining on 31st October 1927.

Proposed scale of survey.	Frontier Circle.	Central Circle.	Southern Circle.	Eastern Circle.	Burma Circle.	TOTALS.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>
1 $\frac{1}{4}$ -inch & over	47,669	...	...	...	...	47,669
1-inch ...	61,778	51,172	115,609	128,285	110,478	467,317
$\frac{1}{2}$ -inch ...	205,427	148,739	...	50,445	21,538	426,149
$\frac{1}{4}$ -inch ...	81,489	6,658	...	...	...	88,147
Totals.	346,363	206,569	115,609	178,730	132,011	979,282

Table C.—Areas and Cost rates of Surveys, 1926-27.

PARTY AND LOCALITY.		Area in sq. miles of each descrip- tion of work.	Cost rate per sq. mile (in- cluding computa- tion and mapping).	Sq. m.	Total ex- penditure October 1st 1926 to Sept. 30th 1927.	Overall cost rate of Topo- graphical Survey.	REMARKS.
Character of country.	Scale and description of work.						
"A" Company.—North-West Frontier Province.							
Medium & high hills partly wooded	One-inch	3,301	4'3				FRONTIER CIRCLE.
Ditto	... One-inch	2,301	11'9				
Ditto	... One-inch	728	.....			
Bare medium hills	... 1½-inch	81	157'1				
Medium hills, thickly wooded	... Four-inch	20	193'8	4,382	1,81,989	41'5	728 sq. miles surveyed in recess 1927.
Bare hills	... Two-inch	85	6'7				
Bare hills and cultivated plains	... 1½-inch	691	10'8				
Punjab—							
Undulating country	... 1/13333	93	212'9				
Ditto	... 1½-inch	408	10'8				
"B" Company.—Sind (Karāchi and Hyderābād districts)							
and Baluchistan (Las Bela and Kalāt States).							
Bare rocky hills	... 1½-inch	35	41'9				(a) Excluding the follow- ing:— Rs. Drawing and Re- production Sec- tion ... 12,497 Purchase of Quetta Office ... 52,908 Miscellaneous special jobs ... 1,528 66,933 The cost rate in column 5 also exclude the above amounts and also Rs. 62,799 the cost of training officers.
Open desert plain	... One-inch	1,870	9'3				
Irrigated plain with jungle	... 1½-inch	270	15'2				
As above, and desert	... 1½-inch	811	29'9				
	... 1½-inch	1,618	16'0				
	Half-inch	1,076	30'6(a)				
Very difficult rugged hills	One-inch	3					
Karāchi—	... One-inch	260					
City Area and Environs	... Four-inch and Three-inch	101	219'8	3,869	204,939 (a)	52'9	
No. 23 Party.—Punjab—Haveli Irrigation Project.							
Cultivated plains and desert	Four-inch			585	45,046	77	
country with scrub jungle.	Special survey	585					

Table C.—Areas and Cost rates of Surveys, 1926-27.

PARTY AND LOCALITY.		Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1926 to Sept. 30th 1927.	Overall cost rate of Topographical Survey.	REMARKS.
Character of country.	Scale and description of work.						
No. 1 Party.—Bihar.							
Jungle-covered hills, open plateaus	One-inch Triangulation ...	2,186	6'5	1,746	(a) 1,36,225	78'0	CENTRAL CIRCLE. (a) Excluding Rs. 15,500 for Benares City Traverse.
Low hills and narrow valleys mostly covered with thick jungle.	One-inch Original survey ...	693	25'0				
Do. do.	Two-inch Original survey ...	1,053	32'1				
Benares City area.—	...	5,120	3'6 per acre.				
Congested narrow lanes	... 16- and 64-inch Traverse	Areas of 8 sq. miles.					
No. 5 Party.—Central Provinces.							
Heavily wooded hills, partly cultivated and undulating.	One-inch Triangulation ...	2,220	6'6	3,066	58,951	19'22	*Excludes:— (i) Muttra Nazul land Survey (additional debit) & fairmapping Rs. 682. (ii) Beas Reservoir Survey (additional debit) Rs. 391. (iii) Fairmapping of Lahore Town Survey (additional debit) Rs. 795. (iv) Fairmapping of Punjab U. P. boundary demarcation Rs. 689.
Undulating low hills, heavily wooded for greater part.	One-inch Original survey ...	2,165	23'75				
	One-inch Supplementary survey	901	8'58				
No. 22 Party.—Punjab.							
Ravi riverain tract, level plain, fairly open.	24-inch Cadastral survey Traverse	250	4,32'3		1,14,367*		
Indus and Panjnad riverain tracts, level plain, mostly wooded.	Punjab-Bhawalpur boundary demarcation Traverse	37 (linear miles).	15'5 (per linear mile).				
Upper Bari Doab Canal headworks and Chakki Khad diversion works, submountainous country.	Eight-inch survey, including traversing, planetabing, without mapping	14	4,08'4				
Jhansi Survey Detachment.—U. P. & C. I.							
Open cultivated plain & hillocks	One-inch Supplementary Triangulation	538	3'2		1,929		
Undulating wooded plains and occasional low well wooded hills.	{ One-inch Original survey	1,078		2,970	80,710	27'8	
	{ One-inch Resurvey	1,892	27'2				

Table C.—Areas and Cost rates of Surveys, 1926-27.

PARTY AND LOCALITY.		Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1926 to Sept. 30th 1927.	Overall cost rate of Topographical Survey.	REMARKS.
No. 6 Party.—Hyderābād State & Central Provinces.							SOUTHERN CIRCLE.
Flat cultivated plains and intricate jungle-covered hills.		3,452	16·3 (a)				(a) This has been arrived at by having the cost of survey and dividing between scales viz., 1½-inch and ¾-inch mapping both scales having been drawn in the party in the same recess season.
Interiors of caves and hills		1,007	7·3 (a)				
A typical Indian cantonment		2	9·5 (b)	5·130	1,29,122 (d)	25·2	
Chiefly flat country covered with One-inch thick forest.		387	16·3 (a)				
Do. do. do.		239	7·3 (a)				(b) Cost of survey only, no mapping of this has been done in this party.
¾-inch mapping of same areas		4,489	12·0 (a)				(c) This includes mapping only which being recoverable from Hyderābād Govt. should be credited to surveys on 1½ & ¾ inch scales.
2-inch mapping forest areas		555	7·9 (c)				(d) Excludes Rs. 6,745 on account of survey of coal mines and special Guide Map of Ellora and Ajanta.
No. 7 Party.—Madras, Hyderābād and Mysore.						17	* This includes about 85 square miles surveyed in parts of 57 A/3, 4 & 7.
Open, undulating with isolated hills; rocky and jungle-clad hills.		4,059	28·4	4,970*	84,058		(a) Includes 1", 4" and 16" original and revision.
Steep and heavily wooded hills		260	1·5				(b) Includes cost of triangulation, computation and fairmapping.
No. 8 Party.—Madras Presidency and States.		502	2·9	4,933	759	33	(c) Includes cost of computation.
Wooded hills		149	0·9				(d) Includes cost of taking and leaving the field.
Plains.—Madras Presidency hills		6·5	759				(f) Worked on the Total cost 95,856 and area 4,658.
Do. and Mysore State		1,490†	(f)				† Includes 69 sq. miles surveyed on 4" scale for the Cauvery (Matur) Project by No. 7 Party in 1925-26.
Bombay Presidency.		2,976	20·6	4,728 (a)	157,725 (b)		
Forest-clad hills		192					
Madras Presidency and Madras States.		47	208·5				
Wooded and open slopes		13	(d)				
Madras Presidency and Madras 16-inch States.		10	1,371				
Madras Presidency and Madras One-inch States.		64	66·9 (c)				
		4,382	(c)				

Table C.—Areas and Cost rates of Surveys, 1926-27.

PARTY AND LOCALITY.		Area in sq. miles of each descrip- tion of work.	Cost rate per sq. mile (in- cluding computa- tions and mapping).	* Total area of Topo- graphical Survey.	Total ex- penditure October 1st 1926 to Sept. 30th 1927.	Overall cost rate of Topo- graphical Survey.	REMARKS.
Character of country. Scale and description of work.			Rs.	Sq. m.	Rs.	Rs.	<u>EASTERN</u> <u>CIRCLE.</u>
No. 4 Party.—Chotā Nāgpur and Bengal.							
<i>Open Plateau and densely wooded One-inch Triangulation ... hills and valleys.</i>		3,900	5·2				
<i>Undulating ground, partly open One-inch Supplementary survey and partly jungle-clad.</i>		3,076	32·7	3,076	1,21,438	39·4	
<i>Flat jungle-clad country with Levelling for one-inch survey ... patches of cultivation.</i>		54 (Linear miles).	7·3				
No. 9 Party.—Orissa and Bengal.							
<i>Undulating wooded hills; mainly One-inch Triangulation ... Sāl forest.</i>		1,296	6·9				
<i>Open flat plains partly wooded. One-inch Traverse ...</i>		1,120	10·4				
<i>Undulating wooded hills, and open One-inch Original survey ... plains with wooded patches.</i>		1,867	33·3	3,323	1,23,872	37·2	
<i>Low hills and open undulating One-inch Supplementary survey plains with wooded patches.</i>		1,439	26·1				
<i>Calcutta city area ... Six-inch revision survey ...</i>		17	72·7				
No. 12 Party.—Assam and Bengal.							
<i>Plains, partly open, but mostly One-inch Original survey ... covered with high grass, Sāl One-inch Triangulation ... and Semul jungle. One-inch Traverse</i>		1,816 1,210 680 (Linear miles).	57·1 4·6 27·8 per (Linear mile).	2,752	1,49,300	54·2	
<i>Gāro Hills and Khāsi Hills.</i>							
<i>Densely wooded hills ... Half-inch Original survey ...</i>		936	36·4				
<i>Half-inch Triangulation ...</i>		1,811	5·2				

Table C.—Areas and Cost rates of Surveys, 1926-27.

PARTY AND LOCALITY.		Area in sq. miles of each descrip- tion of work.	Cost rate per sq. mile (in- cluding computa- tion and mapping).	Sq. m.	Rs.	Total ex- penditure October 1st 1926 to Sept. 30th 1927.	Overall cost rate of Topo- graphical Survey.	REMARKS.
No. 10 Party.—Lower Burma.								BURMA CIRCLE.
<i>Level open cultivated country</i>	... One-inch Traverse	999 (Linear miles).	38'9 (per linear mile).					
<i>Low wooded hills and cultivation</i>	... One-inch	1,358	54'8					
<i>Mostly open cultivation; also low wooded hills and Delta forest.</i>	... One-inch	1,060	43'6					
<i>Jungle-clad hills</i>	... One-inch	580	31'1					
<i>Low undulating forest-clad hills</i>	... Two-inch	62	124'2					
No. 11 Party.—Lower Burma.								
<i>Jungle-clad hills and undulating country mostly jungle-clad.</i>	One-inch Triangulation	2,120	9'6			1,89,854 (a)	62	(a) Includes Rs. 7,707 debitable to the Forest Department, Burma.
<i>High hills densely wooded</i>	... One-inch	92 (Linear miles).	44'8 (per linear mile).					
<i>Undulating and wooded</i>	... One-inch	2,359	61'0					
<i>High hills densely wooded</i>	... One-inch	209	37'6					
<i>Low wooded hills</i>	... Four-inch	35	313'0					
<i>Maymyo Guide Map</i>	... Four-inch	2	141'6 (b)					
No. 21 Party.—Upper Burma—Reserved forests.								
<i>Steep rugged hills densely wooded</i>	Four-inch Traverse	542 (Linear miles).	122'7 (per linear mile).					
<i>High densely wooded hills</i>	... Two-inch	411	167'2					
<i>Wooded hills and undulating country.</i>	... Four-inch	82	361'9					
<i>Densely wooded hills</i>	... Four-inch re-survey	16						
				509	1,79,765 (d)		353	(d) The whole cost is debitable to the Forest Department, Burma.
				2,646	1,95,696 (c)		74	(b) Excludes cost of mapping. (c) Includes Rs. 506 debitable to the Forest Department, Burma.

Table D.—Average monthly out-turns, 1926-27.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 Working days.

PARTY.	LOCALITY.	PLANETABLING.												TRIANGULATION.				TRAVERSING.				MISCELLANEOUS.				REMARKS.
		1-INCH.		1½-INCH.		2 INCH.		4 INCH.																		
		Original or re-survey.	Supplementary or re-survey.	Original or re-survey.	Supplementary or re-survey.	Original or re-survey.	Supplementary or re-survey.	Revision survey.	(Original survey.)	3-inch survey.	4-inch survey.															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	<u>FRONTIER CIRCLE.</u> 4-inch in congested area, 3-inch in environs.		
"A" Company.	Peshāwar, Hazāra, Attock & Rāwalpindi Dists.	...	...	45	...	28	48	138	...	...	...	...	...	Sq. miles.	...	Linear miles.	...	...	...	...	...	...	...
				
				
				
				
"E" Company.	Karāchi Dist. & Las Bela State.	51	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		...	...	34	...	24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
				
				
				
No. 23 Party.	Kalāt State. & Sibi dist. & Hyderabad dist. Karāchi & Hyderabad dists.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
				
				
				
				
				

4-inch in congested area, 3-inch in environs.

Table D.—Average monthly out-turns, 1926-27.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 Working days.

PARTY.	LOCALITY.	PLANETABLING.												TRIANGULATION.			TRAVERSING.				MISCELLANEOUS.		REMARKS.
		½-INCH.			1-INCH.			1½-INCH.			2 INCH.			4 INCH.									
		Original or re-survey.		Supplementary or revision survey.	Original or re-survey.		Supplementary or revision survey.	Original or re-survey.		Supplementary or revision survey.	Original or re-survey.		Supplementary or revision survey.	Original or re-survey.		Supplementary or revision survey.	Original or re-survey.		Supplementary or revision survey.	Original or re-survey.			
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
No. 4	Chotā Nāgpur	...	Sq.	miles.	...	...	...	...	...	...	...	...	Sq.	miles.	...	Linear	miles.	...	Linear miles.	...	...	...
	Chotā Nāgpur and Bengal.	...	...	...	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Bengal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	
No. 9	Orissa	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	66	...	...	...	...	...
	Orissa and Bengal.	...	...	23	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	
	
No. 12	Assam and Bengal.	53	...	24	...	...	...	...	...	...	...	...	523	478	...	...	39	...	...	...	...	...
	
	
	

**EASTERN
CIRCLE.**

Table D.—Average monthly out-turns, 1926-27.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 Working days.

PARTY.	LOCALITY.	PLANETABLING.												TRIANGULATION.		TRAVERSING.				MISCELLANEOUS.				REMARKS.
		½-INCH.		1-INCH.		1½-INCH.		2 INCH.		4 INCH.														
		Original or re-survey.	Supplementary or re-survey.	Original or re-survey.	Supplementary or re-survey.	Original or re-survey.	Supplementary or re-survey.	Original survey.	Original survey.	Original survey.	Original survey.													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	BURMA CIRCLE. (a) Maymyo Town Guide Map. Original and Supplementary Survey.
No. 10	Lower Burma	...	Sq.	miles.	27	39	...	8	...	...	...	...	Sq.	miles.	...	Linear	57	...	...	...	...	...	...
No. 11	Lower Burma	...	...	25	36	...	...	...	4(a)	...	...	...	...	240	...	...	15	...	...	...	...	...	...
No. 21 (Burma Forest).	Burma Reserved Forests.	...	...	...	...	...	...	7	3	...	...	...	...	...	...	...	...	19	...	...	...	...	...

V.—SURVEY REPORTS, FRONTIER CIRCLE.

DIRECTOR:— { Lieut.-Colonel R. H. Thomas, D.S.O., R.E., to 18-11-26.
Colonel C. P. Gunter, O.B.E., R.E., from 19-11-26 to 26-12-26 and
from 27-4-27.
Lieut.-Colonel R. H. Phillimore, D.S.O., R.E., from 27-12-26 to
26-4-27.

46. Summary.—The units administered by the Frontier Circle were “A” and “E” Survey Companies, Nos. 18, 23 and 24 Parties Settlement Survey Detachment and No. 6 Drawing Office. No. 24 Party was formed from 1st October 1926 for the Rectangular Survey of the Lloyd Barrage area for the Bombay Government.

47. Training.—4 Class I (R.E.) probationers, 7 Class II probationers, 18 pupil surveyors, 8 pupil draftsmen and 19 soldier surveyors commenced or continued their training in field and recess work in “A” and “E” Companies and No. 6 Drawing Office during the year. Of the Class I probationers, 2 were confirmed and transferred elsewhere, one proceeded on sick leave and one remained in the Circle. The 6 Upper Subordinate probationers under training last year were confirmed and posted to units and other Circles. One of the 18 pupil surveyors was discharged as unlikely to become efficient. One of the soldier surveyors under second period of training and also one under first period of training were reverted to their regiments. Two soldier surveyors under first period of training were transferred to another Circle.

Special.—Information for insertion in the proposed Indian Supplement of the War Office *Manual of Map Reading and Field Sketching* was compiled during the year and headway was made in the collection of information for the new Field Service Manual (Surveys), now under preparation.

48. *The field work of units was as follows:—*

“A” Survey Company. Topography on 1-inch, 1½-inch and 2-inch scales in sheets 43 B, C & G, 38 N & O; resurvey of Rāwalpindi and Environs on 1/13,333 scale and forest survey in sheets 43 B & F on 4-inch scale. Survey Exercise with the Royal Artillery.

“E” Survey Company. Topography on ½-inch, 1-inch and 1½-inch scales in sheets 35 O & P; 40 C & D; re-survey 3-inch and 4-inch scales of Karāchi and Environs including Manora and Kiamāri. Triangulation and traversing in advance.

No. 18 Party. Air Survey in Waziristān on 1½-inch scale; air survey of Multān and Environs on 3-inch scale. Compilation from rectified mosaics, supplied by Air Survey Company Ltd., of some villages in Chittagong district for Settlement Department, Bengal. Survey Exercise with the Royal Artillery.

No. 23 Party. Topography on 4-inch scale and traversing and demarcation of rectangles for the Punjab Irrigation Department in the area commanded by the Haveli Irrigation Project in sheets 39 M, N & O and 44 A & B.

No. 24 Party. Traversing and demarcation of rectangles for the Bombay Government in the area commanded by the Lloyd Barrage Project in Sind.

Settlement Survey Detachment. Traversing, triangulation and boundary survey in district Peshāwar for the Settlement Department.

“A” Survey Company.

Officer Commanding.—Capt. W. J. Norman, M.C., R.E.

49. General.—The field headquarters are at Rāwalpindi where mobilization stores for a survey section are kept, and Recess headquarters at Murree.

Survey of tribal territory, previously closed to the surveyor, was continued, and the survey of Buner and Swāt, commenced last year, was completed. Some modern sheets of 1905—10 were revised; and considerable areas were triangulated in advance for next season.

50. Average strength during field season was 3 Class I officers, 4 Class II officers, 2 Upper Subordinate officers and 50 Lower Subordinate officers.

Personnel.—Lt. Angwin was transferred to No. 6 Drawing Office in April 1927; Lt. Cadell joined in December; Mr. Alexander (Class II) was lent to No. 24 Party from February till April; Lts. Burn and Wilson joined in July for instruction. Three surveyors were discharged as unlikely to become efficient and two soldier surveyors have been reverted to their regiments; fourteen men were transferred to other Circles and units, and five were received.

51. Field work was organised as follows:—

Camp (1).—Lt. J. B. P. Angwin, R.E., with 7 surveyors surveyed

772 sq. miles on the scale of $1\frac{1}{2}$ inches = 1 mile in Hassan Khel country and the Peshāwar district (sheet 38 O).

Camp (2).—Mr. A. A. Graham (Class II) assisted by Mr. Laltan Khan for part of the season, and surveyors A. S. Siddiqi and Torabaz Khan had charge of the training of one R.E. officer, 7 unclassified surveyors, 6 soldier surveyors and 4 pupil surveyors, and carried out revision survey in the Rāwalpindi district, including the large-scale map of Rāwalpindi and environs (scale 1/13,333).

Camp (3).—Mr. Laltan Khan, C.H., I.D.S.M., (U.S.S.), with 2 surveyors, completed 20 sq. miles of forest survey on the four-inch scale in the Hazāra Division (sheet 43 B/14, 43 F/2, 3).

Mr. Mohammad Hussain Khan, K.S., (U.S.S.), with 11 surveyors surveyed 783 square miles on the one-inch scale in Buner and Swāt (sheet 43 B).

Triangulation.—Mr. T. M. C. Alexander (Class II) triangulated 20 sq. miles in Hazāra district for forest surveys (sheet 43 B/13, 43 F/2 & 3).

Drawing Section.—Mr. F. W. Smith (Class II) with 7 Lower Subordinates carried on fair drawing in Rāwalpindi throughout the field season.

Summer Season.—Field work was also carried out during the summer of 1927 as follows:—

Mr. Afraz Gul Khan, K.S., C.H., (U.S.S.) triangulated 90 sq. miles in sheets 43 F and G in advance for next year's survey.

Mr. Mohammad Hussain Khan, K.S. (U.S.S.) with 6 surveyors carried out original survey on the one-inch scale of 783 square miles in sheets 43 B/1, 5, 6, 9, 10.

52. Areas surveyed.—A total of 2,071 sq. miles was surveyed comprising:—

783 sq. miles of original survey on the scale 1 inch = 1 mile in Buner and Swāt in sheet 43 B; and 81 sq. miles on the scale of $1\frac{1}{2}$ inches = 1 mile in Hassan Khel, Afridi country in sheet 38 O; 20 sq. miles of original forest survey on the four-inch scale in Hazāra in sheets 43 B and F; 1,094 sq. miles of resurvey and revision survey on the scale of $1\frac{1}{2}$ inches = 1 mile in Peshāwar District, N. W. F. P. and Rāwalpindi District, Punjab; 93 sq. miles of resurvey on the scale of 1/13,333 of Rāwalpindi and environs.

53. Recess duties.—Fair mapping was organised in two sections under Messrs Graham and Smith. Owing to various unavoidable delays

and to a summer field season in 1926, large arrears of fair-mapping had accumulated, but these are now being steadily reduced and 15 sheets were submitted for publication.

Sheet 38 H/11 was received from 18 Party with air survey compilation and was fair drawn and submitted. The air survey compilation for the Multān Guide Map was also received from 18 Party and the fair drawing is in hand.

The Rāwalpindi Guide Map was drawn as well as two maps of field-firing areas near Rāwalpindi on the six-inch scale for the local military authorities.

Mapping of the forest surveys in Hazāra district was postponed till next season.

54. Survey Exercise with Royal Artillery.—During October 1926 a Survey section was mobilized to carry out a tactical exercise with the Royal Artillery Survey Section, in order to test the possibilities of carrying forward a system of survey control during a rapid advance, and providing fixed points for the Royal Artillery and air-survey sections.

There was no directing staff for the exercise and no General Staff Officer was present. The principal lessons learnt were, that it is essential to practise co-operation between Survey units, the Royal Artillery and the Royal Air Force in peace, if work is to go smoothly during war, and that it is very desirable to hold an exercise as soon as possible in which all three take part. It was proved that in good weather and suitable country triangulation can keep up with a force advancing 8—10 miles a day; and that, if triangulation breaks down, a short base can be measured and the co-ordinates of points fixed in the area of a battle can be issued within 8 hours. The chief technical problems brought to light were: firstly, how to combine effectively the work of two observers working on the same triangulation, and secondly, how to expedite computations.

“E” Survey Company.

Officer Commanding :—Major E. O. Wheeler, M.C., R.E.

55. General.—The field headquarters were at Hyderābād (Sind), and Recess headquarters at Quetta.

The survey between Karāchi and Hyderābād adjacent to the N.W. Railway was continued and that of Karāchi and environs for the large-

scale Guide Map was completed. 130 square miles were traversed and 35 square miles triangulated for the current season's survey while 140 square miles were traversed in advance for the next season.

56. Average strength during the field season was 3 Class I officers, 10 Class II officers (7 on probation), 1 Upper Subordinate officer and 40 Lower Subordinate officers.

Personnel.—6 Class II probationers and 6 soldier surveyors joined for instruction. 6 U.S.S. officers were transferred to other units.

57. Field work was organised as follows:—

Camp (1).—Lt. D. R. Crone, R.E., with 6 surveyors and 1 soldier surveyor surveyed 270 square miles on the scale of $1\frac{1}{2}$ inches = 1 mile in sheet 35 P/9; 23 square miles on the four-inch scale and 78 square miles on the three-inch scale of Karāchi including the new Drigh Road Cantonment, Airship Base, Karāchi City and Cantonment, Kīamāri and Manora for the Guide map.

A new large-scale map of the major portion of Karāchi itself existed, on scales 20 feet, 40 feet, and 80 feet to the inch. During recess 1926 these large-scale sheets were reduced by hand to 800 feet = 1 inch and thence by photography to 4 inches = 1 mile and the survey of the congested areas was carried out on blue prints on this scale. In small portions, notably the Layāri Quarter, the large-scale map had not been published and survey was carried out *de novo*. In the outlying portions, including the Drigh Road area, three-inch enlargements of the previous season's two-inch topographical survey were made, and the new survey made on blue prints on this scale.

Camp (2).—Mr. A. J. A. Drake, D.C.M., (Class II), with 7 Class II probationers, 1 surveyor and 3 soldier surveyors surveyed 539 square miles on the scale $1\frac{1}{2}$ inches = 1 mile, and 807 square miles on half-inch scale in sheet 35 O, north and east of Karāchi.

Camp (3).—Mr. Imam Din (U. S. S.) with Lt. Wright, R.E., and 2 surveyors, 7 soldier surveyors and 1 traverser, surveyed 270 square miles on the scale of $1\frac{1}{2}$ inches = 1 mile, re-surveyed 539 square miles on the same scale, and 269 square miles on the half-inch scale in sheets 35 O and 40 C.

Camp (4).—Mr. F. J. Grice, (Class II), with 7 surveyors and 1 traverser surveyed 541 square miles on the scale of $1\frac{1}{2}$ inches = 1 mile (original survey) and resurveyed 270 square miles on the $1\frac{1}{2}$ -inch scale and 3 square miles on one-inch scale. They traversed an area of 140 square miles in advance in sheet 40 D/1.

Triangulation and Traversing.—Lt. H. W. Wright, R.E., triangulated 35 square miles in sheet 40 C for use in the current season. 130 sq. miles were also traversed by camp 3 in this sheet. The triangulation was based on Rakhrāi H. S. and intersected point No. 4 of the Karāchi longitudinal G. T. Series, and the traversing on Rakhrāi and Jharrak (Jherruck) hill stations of the same series. Further traversing for next season's survey was carried out by Camp No. 4 as shown above.

Drawing and Reproduction Section.—Mr. Sadiq Ali (lent by the P. L. O.) with 11 men formed a permanent drawing and reproduction section at Quetta. The latter carried out many jobs for other departments, amongst which was the preparation of route plans showing the traffic arrangements for H. E. the Viceroy's visit to Quetta. Some reproduction work was also done for No. 24 (Sind Rectangulation) Party.

58. Areas surveyed.—Original survey of 811 square miles on the scale of $1\frac{1}{2}$ inches = 1 mile; resurvey of 23 square miles on the scale of 4 inches = 1 mile; 78 square miles on the scale of 3 inches = 1 mile; 1,618 square miles on the scale of $1\frac{1}{2}$ inches = 1 mile; 3 square miles on the 1-inch scale; and 1,076 square miles on the scale of $\frac{1}{2}$ inch = 1 mile; making a total area of 3,609 square miles of original survey and resurvey, on all scales. All this work lay in sheets 35 O and P and 40 C and D, in the Karāchi and Hyderābād districts of Sind and in the Indian State of Las Bela, in Baluchistān.

59. Recess duties.—During recess two fair mapping sections were organised, one in charge of Mr. F. J. Grice assisted by Mr. Najam-uddin; and the other in charge of Mr. Imam Din assisted by Mr. Ghulam Hassan. The computing section was in charge of Mr. J. C. Berry.

The mapping of all field work was completed during the year, with the exception of the Karāchi Guide Map, a single one-inch and four half-inch sheets, which are now well in hand and will be completed by the permanent drawing section before 31st March 1928.

No. 18 (Air Survey) Party.

Officer in charge.— { Captain G. F. Heaney, R.E. to 15-5-27 and from 16-7-27.
 „ G. H. Osmaston, M.C., R.E. from 16-5-27 to 15-7-27.

60. General.—The functions of this party are fivefold:—

(i) Compilation of small-scale maps of inaccessible areas in unadministered territory. (ii) Experimental compilation of maps on medium and large scales in British India. (iii) Training personnel in air survey

work generally. (iv) Preparation of data, equipment for war, and organisation of the Air Survey Sections of No. 1 and No. 2 Survey Companies. (v) Map Reproduction and organisation of the Vandyke Reproducing section of No. 1 Survey Company.

During the year progress has been made in all the above.

It was hoped that the latest type of air-survey camera, the F(8), which had been on order some time, would be available for work during the field season, and the Multān survey was postponed in the hope of its arrival. Owing, however, to industrial troubles in England, which delayed production, the camera had not arrived in the country at the end of April. The want of the latest air-survey equipment and of pilots and photographers with special experience of air-survey work, has been keenly felt; until these are available it will be impossible to determine the value of air survey for medium and large-scale work.

The headquarters of the party are at Murree, the field headquarters at Peshāwar.

61. Personnel.—The strength of the party was 1 U. S. S. and 3 Surveyors excluding the reproduction section.

62. Areas surveyed.—110 square miles on 3-inch scale of Multān and surrounding country from photographs supplied by No. 27 Squadron R.A.F; 4 square miles on 16-inch scale for cadastral maps from photographs of Bengal by the Air Survey Company Ltd.; 40 square miles on 4-inch scale of Chittagong district from photographs by the same Company.

63. Multān and surrounding district.—The original 1-inch maps of Multān district are very out-of-date, and as work on irrigation projects, which will materially alter the face of the country, is now in progress, it was not considered advisable to revise the 1-inch maps. This 3-inch survey of Multān and surrounding country was undertaken to supply the need for an up-to-date map for military training purposes etc. The 3-inch scale was adopted, as it is the accepted scale for position maps, and is the largest scale on which the city and usual Brigade training area could be included, without making the map too large to print in one sheet.

Owing to the non-arrival of the F(8) camera the photography was carried out with the ordinary type of L.B. camera. A detachment of two D.H. 9.A machines from No. 27 Squadron R.A.F., Risalpur, proceeded to Multān for the work. All plates were developed and 1 print of each handed over to the Officer in charge, No. 18 Party, before the detachment left. The country was quite level and open and therefore suitable

for air survey. The camera used was fitted with an 8-inch lens and was flown at a height of about 9,600 feet above ground level giving a scale of about 4.4 inches to the mile.

A one-inch map was given to the R.A.F. on which the position of each "key strip" and "cross strip" required was marked. On receipt of a batch of prints the position of each was located and marked up on an index map on the 1-inch scale and the R.A.F. was informed exactly what ground they had covered and how any gaps were to be filled, etc. The prints were then fastened down by strips, on pieces of elastic, and a rough mosaic made by fitting these together and pasting down on to Bristol board. No attempt was made at control beyond obtaining the best fit between strips. This mosaic was then cut into pieces and given to surveyors to take out on the ground in order to fill in names and relative heights and to interpret any obscure detail.

Control was obtained as follows. Three "key strips" were prepared from photographs taken in an east and west direction across the top, middle and bottom of the area, the remainder of the area was then covered by a "cross strip" taken in a north and south direction. The photographs of "key strips" were each mounted separately on the left hand pages of an "album", made from an ordinary exercise book with slits cut in the pages to receive the photographs. These albums were then taken out on the ground and fixed points were identified in the area of each photograph; the particulars of each fixed point, which was only designated by a number on the photograph, were written on the opposite page. Rectangulation had just been carried out over nearly the whole area, so there was no difficulty in obtaining fixed points. When the corner stone of the rectangulation could not be identified in the photograph, some point appearing on it was chained to from adjoining rectangulation pillars and its position fixed by plotting by distances.

Compilation of the maps on the 3-inch scale was carried out in recess; on completion this will be made over to A Company for fair drawing.

64. Survey in Chittagong District.—This survey which covers an area of upwards of 1,500 square miles in sheets 79 M, N and O, and 84 A, B and C is being carried out for the Settlement Officer of Chittagong, to provide maps on a 4-inch scale of hitherto unmapped areas.

The country consists of flat cultivated and thickly-populated plains covered with paddy fields only a few feet above sea-level, interspersed with irregular ranges of hills rising to a couple of thousand feet. These hills are covered with such dense jungle that it is in places very difficult

to distinguish the courses of streams. A certain amount of errors are inevitable in the mapping of hilly country from vertical photographs but these have been reduced as far as possible by the resection method referred to below.

The photography was carried out by the Air Survey Company Ltd., at the end of the cold weather, and completed by the middle of April. The L.B. type of camera at present in use by the R.A.F. was used. The scale of photography is about 4-inches to the mile.

Rough mosaics were constructed by the company and sent to the Settlement Officer, Chittagong who marked on them the positions of points fixed by traverse. These mosaics were then forwarded to this party, together with plots of the traverse data on a 4-inch scale.

The instructions for mapping received from the Settlement Officer, Chittagong were "to show all roads, streams and the form lines of the hills, boundaries of cultivation and sufficient detail outside the margin of the forest, such as tanks, paths, village sites as would enable a man to identify his position on the forest boundary by reference to outside detail."

After one or two experiments the following procedure has been adopted:—

- (a) Strips of photographs are plotted by the "Arundel" or resection method and the detail required is traced on to celluloid.
- (b) These strips are then scaled by the use of photography and an enlarging lantern.
- (c) The traverse data is traced from the plot on a sheet of celluloid and the scaled strips are traced on this, any small adjustments between the edges of strips being made.
- (d) Overlapping photographs are now examined through a stereoscope and form lines are drawn on the prints. These prints are then placed under the celluloid, their positions adjusted by the outline and the form lines are traced.
- (e) The map is transferred from the celluloid to a fair sheet.

Considerable difficulty and inaccuracy has been caused by the longitudinal overlap in many strips being too small. Where this overlap falls below 50% the resection method of plotting mentioned above cannot be carried out, and this method appears to be the only one which overcomes the inaccuracies arising from differences in the height of ground covered by a strip of photographs. With the excep-

tion of this defect the standard of photography has been extremely high and is incomparably better than that carried out by service machines, a special feature being the extreme clearness of the prints provided.

At the time of writing only forty square miles have been mapped, and the work has not yet progressed sufficiently to enable a true estimate of its accuracy or cost to be formed. These subjects will be dealt with in next year's report.

65. *Special surveys for experimental purposes.*—A cadastral map on the 16-inch scale of 4 square miles in Bengal Sheet No. 79 N was compiled from a rectified mosaic on the same scale from photographs taken by the Air Survey Company Ltd., this compilation was submitted to No. 1 Drawing Office, Calcutta for fair-mapping.

66. *Miscellaneous.*—A tactical exercise in which Captain G. F. Heaney, R.E., and two surveyors of this party took part was carried out in conjunction with the Artillery Survey Section in October 1926 in the vicinity of Abbottābād. For further details see the report by the Officer Commanding "A" Survey Company at p. 38.

67. *Reproduction.*—During the field season a small reproduction section was added to the party. It is equipped with a portable hand-press (Lieut. Chase's pattern), which can take plates up to 13" by 18", and with apparatus for preparing zinc plates by the Vandyke process. Various maps and diagrams were reproduced on payment for Military authorities, and the section was also of use in printing forms for departmental use. Details of work done will be found in the Map Publication Report.

It is hoped that the section will be enlarged so as to be capable of forming the Vandyke Reproducing Section of No. 1 Survey Company on mobilization.

68. *New Instruments received.*—One Stereoscope and counter plotter by Hilger was received during recess and will be reported on in next year's report.

No. 23 Party.

Officer in charge.—Mr. H. B. Simons.

69. *General.*—The party was employed on behalf of the Punjab Government in traversing, subdividing to 25 and 100 acre rectangles and surveying an area in sheets No. 39 M, N, O and 44 A and B commanded by the Haveli Irrigation Project.

The Traverse camp with headquarters at Khānewāl opened on the 1st of September 1926 to enable the traversing and a sufficient number of 2,400 acre rectangles, which form the basis of further subdivision, to be completed before the rest of the party took the field in November 1926. The Rectangulation camps were moved out as soon as main rectangles were ready for subdivision. The Topographical section was employed on the reduction of boundaries till the end of December when a sufficient area had been subdivided to provide work for the 10 surveyors.

The headquarters for the field was located at Multān and was moved to Karāchi for the recess.

70. Personnel.—The strength of the party was considerably increased owing to the large programme. The field strength of the party numbered six Class II officers, three Upper Subordinate Officers and 158 Lower Subordinate Officers (most of the latter being on the *purely temporary* list) and were distributed as under:—

Mr. O. N. Pushong (Class II) with 20 traversers and 10 computers traversed and computed in the field the whole area covered by the project and embedded the corner stones of the main 2,400 acre rectangles. Mr. Pushong having completed his programme by the middle of January 1927 was transferred with all his camp to No. 24 Party.

Mr. Jiya Lal Sahgal (Class II) assisted by Mr. J. P. Vastav (U. S. S.) and 35 rectangulators subdivided the southern half of the country to the east of the Chenāb River.

Mr. Abdul Karim (Class II) with 36 rectangulators subdivided into 25 and 100 acre rectangles the area to the west of the Chenāb River.

Mr. Duni Chand Puri (Class II) with 10 surveyors completed the topographical survey of a portion of the country on the west bank of the Chenāb River.

Mr. Mohammad Najamuddin (Class II) with Mr. Abdul Majid (U. S. S.) as assistant and 35 rectangulators subdivided to 25 and 100 acre rectangles the northern half of the area on the east bank of the Chenāb River.

Mr. Latif Khan (U. S. S.) with 5 draftsmen was employed throughout the field season on the reduction of boundaries from village *musāvis*.

71. Area surveyed.—A total area of 2,295.9 square miles was rectangulated of which 837.4 square miles was subdivided into 25 acre

blocks and the remainder, 1,458.5 square miles, into 100 acre blocks. 2,557.2 linear miles of traverse was run and 585 square miles of original survey completed on scale 4 inches = 1 mile.

The country comprises cultivated plains watered by inundation canals and desert country with scrub jungle which in parts was exceedingly heavy, necessitating a considerable amount of clearing.

72. Traversing.—The traverse covered the whole area and was controlled by connection, on the left bank, to intersected points of the Sutlej Series and G. T. Traverse Stations, and on the right bank to Māhiwāla T. S. of the Great Indus Series and certain minor stations of the Sind-Sāgar Series.

73. Rectangulation.—The positions of the corners of the main 2,400 acre rectangles were computed from the traverse and marked by stones embedded by the traverse camp. These 2,400 acre rectangles were later subdivided to 25 and 100 acre blocks, according to the requirements, by the rectangulation camps.

74. Topographical surveys.—Mr. Duni Chand Puri was in charge of the plane-tableing which was carried out on the scale of 4 inches = 1 mile.

75. Recess duties.—Mr. Duni Chand Puri was in charge of a drawing section of 12 draftsmen employed on completing the field sections, preparing the spot height and contour charts and reducing the boundaries of village *musāvis* for the next field season.

No. 24 Party.

Officer in charge.— $\left\{ \begin{array}{l} \text{Major H. E. Roome, M.C., R.E., from 1-10-26 to 19-5-27} \\ \text{and from 22-8-27,} \\ \text{Mr. O. N. Pushong, from 20-5-27 to 21-8-27.} \end{array} \right.$

76. General.—In 1926, the Bombay Government requested the Survey of India to submit proposals for carrying out a rectangular survey over the area of Sind commanded by the Lloyd Barrage Project. As a result, No. 24 Party was formed on 1st October 1926, to demarcate an area of approximately 12,000 square miles into rectangles of 64 acres in size, the whole project to be completed in 4 years. The field headquarters of the Party opened at Hyderābād (Sind) on 15th October 1926, and, on conclusion of the field work early in April the headquarters moved to Karāchi.

77. Personnel.—The field strength of the Party numbered 2 Class II officers, 1 Upper Subordinate Service Officer, and about 57 Lower

Subordinate Officers, most of whom are borne on the *purely temporary establishment*. Under Mr. O. N. Pushong (Class II), on completion of his work early in January 1927 in No. 23 Party on the Haveli Irrigation Project, were 19 traversers, while the balance of the traversers was under Mr. Amrit Ram (U. S. S.) assisted, for one month only, by Mr. T. M. C. Alexander (Class II).

78. Area rectangulated.—It was decided that the area of a main rectangle, on which further subdivision is based, should be 4 square miles. The co-ordinates of the corners of these rectangles were computed, and their positions on the ground determined by 3,688 linear miles of traversing and marked by stones. These corners were demarcated over an area of 3,590 square miles in the Lārkāna and Nawābshāh districts. The next operation, known as exterior rectangulation, consists in sub-dividing the exterior sides of these main rectangles and this was completed over an area of 1,294 square miles.

The work was controlled by connection to the intersected points and certain stations of the triangulation carried out in 1898 and following years. Many of these stations and practically all of the village trijunctions, which were traversed about the same time, have entirely disappeared, no measures for their maintenance having been adopted by the local authorities. The majority of the identified points were large tombs, which have been preserved by villagers from religious and sentimental motives, thereby forming excellent permanent marks.

The country dealt with is flat, and lies on either bank of the river Indus. A considerable portion of it is already cultivated under a system of inundation canals, while the remainder consists of desert areas containing scrub jungle and sand hills. Thickly wooded areas occur in the neighbourhood of the Indus, necessitating heavy cutting for line clearing.

79. Miscellaneous.—At conferences held at Karāchi in April 1927, it was decided to modify the original proposals and to restrict the scope of the present project to sub-rectangles of 320 acres in size, in order to economise the number of stones laid down, many of which, it is anticipated, will not be used for some years, when they may have disappeared.

A professional publication entitled "Report on Irrigation Surveys 1926" is in the press.

80. Recess duties.—Mr. Amrit Ram was in charge of the computing section of 9 men during recess, completing and binding the computations

of the field season; preparing maps and charts required by the Chief Engineer, Lloyd Barrage and Canals Construction, etc., and computing data in advance for next field season.

Settlement Survey Detachment.

Officer in charge.—Rai Sahib Maya Das Puri, (Class II).

81. General.—The detachment continued the work of traverse, triangulation, and boundary survey in continuation of last year's programme in district Peshāwar (*tahsils* Peshāwar and Nowshera) in degree sheets 38 N and O, and 43 C for the Settlement Officer Peshāwar. The field headquarters were at Campbellpore and the detachment recessed at Murree.

82. Personnel.—The field strength of the detachment consisted of 3 Upper Subordinate officers, and 69 Lower Subordinates, distributed as follows:—

Mr. Muhammad Husain (U. S. S.), *Camp (1)*, with 11 traversers.

Mr. Dalip Singh Gandhi (U. S. S.), *Camp (2)*, 12 traversers.

First class Surveyor Muhammad Ayub Khan, *Camp (3)*, 2 surveyors. This officer also carried out plane-tabling himself.

Mr. Mohabat Lal Kohli (U. S. S.), and 43 lower subordinates were employed on plotting, computations, area extraction, reduction of *musāvis*, etc.

Camps (1) and (2) traversed and triangulated in the Peshāwar *tahsīl*. *Camp (3)* carried out village boundary survey in the Nowshera hills.

At the close of field operations in April, due to reduction of the programme, Mr. Muhammad Husain was transferred to Geodetic Branch Dehra Dūn, 20 *purely temporary* men were discharged, 3 transferred to other units, and 11 sent on departmental leave.

83. Triangulation and Traversing.—422 square miles of the Peshāwar *tahsīl* and 4 square miles of Nowshera riverain area were traversed and triangulated, a narrow strip of 33 square miles along the Afridi border in the Peshāwar *tahsīl* was left till next season due to political reasons. Village boundaries were surveyed in 149 square miles of the Nowshera hills on the scale 12 inches = 1 mile.

The hilly portions of the Peshāwar *tahsīl* covering an area of 83 square miles (sheet 38 O), were first supplemented with points fixed by minor triangulation and then traversed as usual. No heights were observed as they were not required by the settlement authorities. In 339

square miles of the flat area main circuits were run along main roads and sub-circuits along village boundaries and in the interior of villages, providing about 20 stations per square mile. In villages close to Peshāwar city points were fixed about two chains apart on account of the area being much closed in by gardens. The work was connected with 11 triangulated stations.

The Peshāwar *tahsīl* was generally flat, fertile and well irrigated. The southern and western areas were hilly and intersected by ravines. The Nowshera hills were barren with scattered patches of cultivation.

84. *Plotting, Computing, etc :—*

(a) *Reduction of musāvis.—*

Early in the season Mr. Mohabat Lal Kohli, and Munshi Ruldu Khan, second-class draftsman, with 4 others were employed on the reduction of 24-inch scale *musāvis* (*tahsīls* Chārsadda, Mardān, Swābi) by pentagraph to scale 4 inches = 1 mile for the use of the Settlement Officer, Peshāwar, and to scale $1\frac{1}{2}$ inch = 1 mile for the Officer Commanding, "A" Company for compiling the latest frontier boundary on one-inch sheets.

(b) *Area extraction.—*

During October and November 1926 first-class traverser Lorind Chand with 7 men extracted the areas of 30 villages in the Swābi *tahsīl* by planimeter and graphically.

(c) *Plotting.—*

In the middle of November the replotting of the Nowshera *tahsīl* on superior *musāvis* was taken up on the scale 24 inches to a mile at the special request of the Settlement Officer Peshāwar. The area comprised 702 square miles including 164 villages. Two sections—one under Mr. Mohabat Lal Kohli, and the other under Babu Lorind Chand—were formed with 11 draftsmen in each section. This work was completed by the end of January 1927.

On the completion of the Nowshera replotting the plotting of the Peshāwar *tahsīl* on 24 inch scale, an area of 422 square miles including 277 villages, was commenced by Mr. Mohabat Lal Kohli's section, and continued during the rest of the field season; the other section was disbanded.

(d) *Computations.*—

First-class computer Joti Sarup supervised the computations with the help of 16 computers and proved all the current season's work during the field season. Besides the normal work, the conversion of rectangular co-ordinates into spherical values of the permanent points was started.

85. *Miscellaneous.*—Duplicate traces for the Settlement Officer Peshāwar were made of four-inch Indus congregated maps from Attock bridge to the end of Peshāwar-Hazāra district boundary, showing river detail and boundaries as prepared during the last and present settlements; traces were prepared in duplicate of the four-inch reductions of the frontier boundary (*tahsils* Chārsadda, Mardān, and Swābi) with compiled detail and village boundaries from the four-inch *patwāris*' indexes, and of the quarter-inch index maps of the Swābi, Nowshera and Peshāwar *tahsils* showing assessment circles and necessary detail.

86. *Recess duties.*—During recess the 24-inch plotting and drawing of quarter-inch triangulation and traverse charts were done by Mr. Mohabat Lal Kohli with 9 draftsmen.

The area extraction of 34 villages, containing 80 square miles of the Swābi *tahsīl* was carried by Mr. Dalip Singh Gandhi with 7 computers.

The computation section consisting of 14 men was looked after by the Officer in charge with the help of two senior computers. The rectangular co-ordinates of all the *pakka* points laid out in the whole of the Peshāwar and Peshāwar districts during the last four seasons, numbering over 3,000 were converted into spherical values; the computation records of all the work done during the current season were completed.

Several villages of the Dera Ismail Khān district were compiled on the scale 4 inches = 1 mile and their areas extracted with a view to comparing the same with those worked out at the last settlement, in order to ascertain the standard of accuracy of the existing settlement maps and whether they were fit to be utilized in the coming settlement.

87. In September 1927 a surveyor was deputed to survey an area of 27,200 square yards on the scale of 1 inch=20 feet with contours at an interval of 5 feet, in Sanawar near Kasauli Hill, for the Garrison Engineer, Simla Hills. The Survey was done under the supervision of the Garrison Engineer and the total cost was met by him.

VI.—SURVEY REPORTS, CENTRAL CIRCLE.

DIRECTOR:—{ Lt.-Col. R. H. Phillimore, D.S.O., R.E., to 20-12-26.
 „ L. C. Thuillier, I.A., from 21-12-26.

88. Summary.—The units administered by the Central Circle were Nos. 1, 5 and 22 Parties, Jhānsi and Bhopāl Survey Detachments and No. 3 Drawing Office.

The Bhopāl Survey Detachment was transferred from the administrative control of the Director, Geodetic Branch to that of Director Central Circle on 1st April 1927.

The officer in charge of No. 5 Party in addition to his normal duties, continued to act as Assistant Director of Surveys, Central Provinces, and administered the revenue, town and other surveys of that Province.

89. Training.—At the commencement of the year 22 pupils and 2 soldier-surveyors were under training. Of these pupils 6 were promoted to the unclassified list and the remainder are making satisfactory progress. The two soldier-surveyors completed their first period of training in April and have been recommended for a second period of training.

Two soldier-surveyors under training were transferred to the Central Circle from the Frontier Circle in May 1927.

90. *The field work* of parties and detachment was as follows:—

No 1 Party.—Topography on the scales of 2 inches and 1 inch = 1 mile in sheets 64M and 73A. Traversing of Benares City for large-scale survey.

No. 5 Party.—Topography on scale 1 inch = 1 mile in sheet 55 P.

No. 22 Party.—Traverse and compilation of settlement *musāvis* in Lyallpur, Montgomery and Sekhūpura districts. Demarcation of a part of the boundary between Dera Ghāzi Khān district and Bahāwalpur State. Eight-inch survey of a portion of the Upper Bāri Doāb Canal area.

Jhānsi Survey Detachment.—Topography on scale 1 inch = 1 mile in sheets 54O and P.

No. 1 Party.

Officer in Charge.—Major R. Foster, I.A.

91. General.—The party was transferred from the United Provinces to take up special topographical survey on the scale of 2 inches = 1 mile for the Bihār and Orissa Government in Palāmau and Rānchī districts in sheets 64M and 73A. At the same time the sheets in which this area falls were surveyed to margin on the scale of 1 inch = 1 mile.

At the request of the United Provinces Government preliminary traverse of Benares City Municipal Area was carried out with a view to completing a detailed survey on a large scale of that City.

The field headquarters of the party were at Daltonganj, Palāmau district.

92. Personnel.—Two Class II officers were added to the strength of the party, two U. S. S. officers were transferred and one joined. Owing to the difficult nature of the country to be surveyed, 8 pupil surveyors were transferred and seven more qualified surveyors joined, and 6 traversers and 4 computers joined for Benares City work. Two surveyors were transferred to transfrontier work. The field strength of the party numbered 5 Class II officers, 1 Upper Subordinate Service officer and 44 Lower Subordinates, distributed as under :—

Mr. A. M. Talati, L.C.E. (Class II), *Camp (1)*, 10 surveyors.

Major C. H. Tresham, V.D. (Class II), *Camp (2)*, 11 surveyors, increased later to 14 surveyors.

Mr. H. T. Hughes, (Class II), *Camp (3)*, 9 surveyors.

Mr. R. N. Hastir, (U. S. S.), *Camp (4)*, Mr. S. R. Gupta, B.A. (Class II, under training), 6 traversers and 4 computers.

Mr. M. N. A. Hashmi, (Class II) and Surveyor Sardar Khan (L. S. S.) were employed on triangulation.

93. Areas surveyed.—An area of 1,053 square miles was surveyed on the scale of 2 inches = 1 mile in sheets 64 M and 73 A in Palāmau and Rānchī districts (Bihār and Orissa) including an area of 239·6 square miles of Government forest; an area of 693 square miles on the scale of 1 inch = 1 mile was surveyed in sheet No. 73 A, in Hazāribāgh, Palāmau and Rānchī districts and Surgujā State (C. P.). An area of 2,186 square miles was triangulated in advance in sheets 72 D and 73 A.

94. Topographical surveys.—

Camp (1) under Mr. A. M. Talati, L.C.E., surveyed 246·7 square miles on the scale of 2 inches = 1 mile in Palāmau district and 447·6 square miles on the scale 1 inch = 1 mile in Hazāribāgh, Palāmau and Rānchī districts.

Camp (2) under Major C. H. Tresham, V.D., surveyed 527·1 square miles on the scale of 2 inches = 1 mile and 181·4 square miles on the scale of 1 inch = 1 mile in Palāmau district.

Camp (3) under Mr. H. T. Hughes, surveyed 279·2 square miles on the scale of 2 inches = 1 mile in Palāmau and Rānchī districts and 64 square miles on the scale of 1 inch = 1 mile in Palāmau district and Surgujā State (C. P.).

The country in the area surveyed on the two-inch scale consists of irregular ranges of dense forest-clad hills, rising between 3,000 and 4,000 feet above sea level. Open spaces are small and scattered, and communications, other than a few fair roads, are only jungle paths. Along the boundary between Palāmau and Rānchi districts rise the ghats leading up to the Chotā Nāgpur plateau. These are steep and jungle-clad and impassable in many places. The work of the surveyors was considerably hampered by the presence of tigers, many of them man-eaters, which accounted for 12 of the local inhabitants during the period survey work was in progress. The country surveyed on the one-inch scale was less hilly and jungle-covered.

95. Triangulation.—Triangulation was carried out in the south-eastern half of 73 A and one sheet of 73 D, in Hazāribāgh, Palāmau and Rānchi districts and a small area of Jashpur and Surgujā States. Connection was made to the Calcutta Longitudinal Series. •

96. Special surveys.—*Camp (4)* under Mr. R. N. Hastir completed the traverse of Benares City Municipal Area as a preliminary to taking up a detail survey of the City. 226 linear miles of traverse were carried out and 7,016 stations were fixed. The work was very difficult and arduous owing to the vast crowds, chiefly pilgrims, who blocked the streets and lanes. Traversers were compelled in certain localities to work at night. Traverses were run through every lane and principal bye-lane. Through the good work of the police, under the orders of the District Magistrate, and the tact of the officer in charge, the work was completed without any dispute or difficulty arising.

At the request of the Deputy Commissioner, Fyzābād (U. P.), Mr. H. T. Hughes demarcated a disputed boundary between 9 revenue plots in village Bareta in the Suburbs of Ajodhyā City.

97. Recess duties.—The fair mapping on the two-inch and one-and-a-half-inch scales of the field work was divided into three sections under Mr. A. M. Talati, Major C. H. Tresham and Mr. H. T. Hughes respectively and was all completed during the year.

The two-inch mapping was drawn for publication in black and brown only.

Mr. M. N. A. Hashmi and Surveyor Sardar Khan carried out the computation of their own triangulation.

Mr. R. N. Hastir was in charge of the computations of the Benares City traverse.

No. 5 Party.

Officer in Charge.—{ Mr. P. A. T. Kenny, O.B.E., from 1-10-26 to 3-12-26 and from 21-3-27.
Major J. D. Campbell, D.S.O., R.E., from 4-12-26 to 20-3-27.

98. General.—This party continued surveys on the scale of 1 inch = 1 mile in the Central Provinces in sheets 55 P and 64 C. The field

headquarters were again situated at Nāgpur in order to keep in touch with the Settlement Commissioner, Central Provinces, the officer in charge of the party being also Assistant Director of Surveys, Central Provinces.

99. Personnel.—The field strength of the party numbered 1 Class II, 3 Upper Subordinate Service officers and about 20 Lower Subordinates distributed as under:—

Mr. J. H. Johnson (Class II), *Camp (1)*, 10 surveyors.

Mr. Shadi Lal Dube (U. S. S.), *Camp (2)*, 3 surveyors and 3 pupils.

Mr. Nur Muhammad (U. S. S.), *Camp (3)*, 1 surveyor and 3 pupils.

Mr. J. R. Chibbar (U. S. S.) and traverser Raghbir Prasad (L. S. S.) were employed on triangulation.

100. Areas surveyed.—An area of 3,066 square miles was surveyed on the scale of 1 inch = 1 mile in 55 P in the Nāgpur, Chānda and Wardhā districts; of this 2,165 square miles was original and 901 square miles supplementary survey, the latter being government forest, for which 4 inches = 1 mile maps exist. An area of 2,220 square miles was triangulated in advance in 64 C for surveys in 1927-28.

101. Topographical surveys.—

Camp (1) under Mr. J. H. Johnson with headquarters at Chānda, surveyed 1,674 square miles on the scale of 1 inch = 1 mile in Chānda district.

Camp (2) under Mr. Shadi Lal Dube, with headquarters at Umrer, surveyed 834 square miles on the scale of 1 inch = 1 mile in the Nāgpur and Chānda districts.

Camp (3) under Mr. Nur Muhammad, with headquarters at Korā, surveyed 558 square miles on the scale of 1 inch = 1 mile in the Wardhā and Chānda districts.

The country surveyed, with the exception of a small open area in the north, is very heavily wooded, with large expanses of Government and *mālguzāri* forests, which necessitated the use of rope chains. Reductions of the 4 inch = 1 mile Forest Survey maps were found to be very accurate and only needed verification of detail on the ground. Forest boundaries were however in parts considerably affected by the creation of large reservoirs for irrigation canals, particularly in the case of the Asola Tank about 10 square miles in area. The climate on the whole was temperate, no extremes of cold or heat, except during the latter half of March, being experienced.

102. Triangulation.—An area of 2,220 square miles was triangulated by Mr. J. R. Chibbar and traverser Raghubir Prasad in 64 C in the Bālāghāt, Bhandāra and Drug districts and the Chuikhadān, Kawardhā, Khairāgarh and Nāndgaon Feudatory States. Progress was much delayed by dense forest, grass fires, haze and refractory menials and the triangulation was not completed till after the party had left for recess quarters.

103. Recess duties.—Mr. J. H. Johnson was placed in charge of the fair-mapping of the party, and was assisted by Mr. Shadi Lal Dube.

The services of Mr. F. B. Kitchen were later lent to the party by No. 3 Drawing Office to take over part of the fair mapping. Mr. Nur Muhammad, Mr. J. R. Chibbar and traverser Raghubir Prasad were responsible for the computations of the triangulation.

104. Miscellaneous.—Owing to the very unhealthy nature of the country, cultivable areas had decreased in many localities, but an effort is now being made by the Local Government to colonise it by the creation of large reservoirs.

No. 22 (Riverain) Party.

Officer in Charge.—Mr. Dhani Ram Verma, R.S.

105. General.—This party works chiefly for the Punjab Government but undertakes special surveys for other Government Departments and Municipalities who pay for the work. The party's programme for the year consisted in (i), traversing the riverain estates along the Rāvi river and laying down base-lines in sheets 44/B, E and F and plotting and compiling settlement *musāvis* for cadastral surveys by the Settlement Department of the Punjab Government; (ii), demarcation of a part of the Punjab-Bahāwalpur boundary, in dispute, lying in sheet 39 L, for the Punjab Government and Bahāwalpur Durbar; (iii), Upper Bāri Doāb Canal Survey on scale 8 inches = 1 mile in the Punjab and Kashmir State, in sheet 43 P, for the Irrigation Department of the Punjab Government.

The headquarters of the party remained at Lahore throughout the year as usual.

106. Personnel.—Owing to the curtailment of the riverain programme the strength of the party was considerably reduced. The party consisted of 2 Upper Subordinates and about 65 Lower Subordinate officers distributed as under :—

Mr. Jamna Prasad, R.S. (U. S. S.), *Camp (1)*, 12 traversers.

Babu Roda Ram (L. S. S.), *Camp (2)*, 13 traversers.

Babu Harnam Singh (L. S. S.), *Camp (3)*, 2 traversers and 4 surveyors.

Mr. Badlu Ram (U. S. S.) and Babu Jalaluddin (L. S. S.), with 16 computers and 15 draftsmen under them respectively, supervised the computing and plotting sections at headquarters.

During the year 2 traversers and 4 surveyors were transferred and 3 traversers were discharged.

107. Areas surveyed.—(a) 14.1 square miles of original survey were completed on scale 8 inches = 1 mile of the Upper Bāri Doāb Canal Head-works in Kashmir State and Gurdāspur district and Chakki Khad Diversion Works in Gurdāspur and Kāngra districts in sheet 43 P.

(b). The area covered by minor traverse for riverain surveys in Lyallpur and Montgomery districts in sheets 44/B, E and F was 250 square miles.

(c). The area covered by main and minor traverses to form basis for the Upper Bāri Doāb Canal Survey on scale 8 inches = 1 mile in sheet 43 P was 15.6 square miles.

108. Plotting Section.—During the field season the plotting section under Babu Jalaluddin plotted traverse *chāndās* on *musāvis* and compiled boundary *musāvis* for cadastral surveys by the Settlement Department. The section also prepared four-inch compilation sheets of the riverain area traversed.

109. Computing Section.—During the field season the section under Mr. Badlu Ram was employed on traverse computations appertaining to the work of the season. The computations were done *pari passu* and the rectangular co-ordinates of the traverse stations were gradually supplied to the plotting section for plotting *musāvis*.

110. Riverain surveys.—Camps (1) & (2) carried out minor traversing of the riverain estates along the Rāvi river in Lyallpur and Montgomery districts for cadastral surveys by the Settlement Department. This was based on main circuits run in previous seasons. Village boundaries were traversed and the areas within them were covered with a traverse network to provide points to facilitate internal measurement by the *patwāri*.

The *kilābandi* boundaries of the villages brought under the *kilābandi* system in Montgomery district were specially surveyed by theodolite traverse, offsets by optical square.

Base-lines were laid out about 1 mile apart beyond the flood line on both sides of the Rāvi river in Lyallpur, Montgomery and Shekhūpura districts and demarcated with permanent mark-stones to serve as bases

for future survey and demarcation of boundaries and fields in the bed of the river.

24-inch *musāvis* of the *kilābandi* villages were reduced by penta-graph to the scale 4 inches = 1 mile for compilation of *kilābandi* boundaries.

All the traverse stations marked during the field season were plotted on four-inch sheets.

The country covered by traverse operations was for the most part densely wooded and involved heavy line-clearing. There was scarcity of labour in the Indus and Rāvi riverain tracts and much of this work had to be done by khalasis.

Plotted and boundary *musāvis* (settlement mapping sheets) of *kishtwār* and *kilābandi* villages on the scale of 1/2640 and traces of four-inch plot sheets were supplied to the Officer in charge, Remapping and Revision of Records of Rights of the Rāvi Riverain Area, Montgomery.

111. *Punjab-Bahāwalpur Boundary demarcation.*—(by Camp 2). This was undertaken for the Punjab Government and Bahāwalpur Durbār. It consisted of the demarcation of the boundary between *mauzās* Kacha Drigh (Dera Ghāzi Khān district) and Bet Wāghwar (Muzaffargarh district) on one side and *mauzās* Mehrān Samūka and Phorān (Bahāwalpur State) on the other side, at the junction of the Indus and Panjnad rivers in sheet 39 L.

For this purpose a theodolite and chain traverse was carried out, connecting with the base-lines laid out in the field season 1918-19.

In the course of demarcation 5 boundary marks were destroyed by a revenue official of Bahāwalpur State. They had to be relaid.

The length of the boundary demarcated was 7.5 linear miles. Boundary plots were prepared on *musāvis* on 24-inch scale and supplied to the Deputy Commissioner, Dera Ghāzi Khān.

112. *Upper Bāri Doāb Canal survey.*—This was undertaken for the Executive Engineer, Mādhopur Division, Upper Bāri Doāb Canal. It consisted of a plane-table survey on the eight-inch scale of the Rāvi river with the Canal Head-works in Gurdāspur district and Kashmīr State, of the Chakki Khad with its Diversion Works in Gurdāspur and Kāngra districts, and of a narrow strip of populated and cultivated country along their banks in sheet 43 P.

Main and minor traverses were carried out to provide points for the plane-tablers. The traverse was computed *pari passu* at the party headquarters.

Connection was made with one principal station and one minor station of the North West Himālaya Series and with base-lines laid out in season 1915-16.

The provincial boundary lying in the bed of the Rāvi river and a district boundary on the Chakki Khad were compiled on scale 8 inches = 1 mile from the settlement *musāvis* of the area surveyed and incorporated in the plane-table sections.

Names and other information of Irrigation interest, supplied by the Executive Engineer, were typed on the original plane-table sections in office. The typed plane-table sections were sent in for reproduction in blue by photozincography. He was supplied with 8 sets of blue prints of the plane-table sections for annual revisionary survey and 2 sets coloured by hand for reference.

A synopsis of the rectangular co-ordinates of the Irrigation Survey pillars, which were specially surveyed by theodolite traverse, was supplied for future use.

The entire cost of the work was debited to the Irrigation Department.

113. Recess duties.—(a) The compiling and plotting section under Babu Jalaluddin compiled settlement *musāvis* in advance of the next season's work and prepared rough field traverse charts for the use of traversers in the next field season.

(b) The computing section, under Mr. Badlu Ram till the end of April, and subsequently under Mr. Jamna Prasad, R.S., completed all traverse computations of the year's work.

(c) The traverse chart section under Mr. Jamna Prasad, R.S., prepared manuscript traverse charts for degree sheets 38/O and P; 43/C, D, G, H and P, 52/D and 53/F.

(d) Babu Harnam Singh was in charge of the fair mapping of Muttra *Nazūl* Land survey on 64-inch scale and the Punjab—U.P. boundary survey on the scale of 4 inches = 1 mile of the last year. 2 large sheets of the former and 4 large sheets of the latter were fair drawn for reproduction by the Vandyke process. The other 4 sheets of the latter will remain incomplete, pending the completion of demarcation of two sections of the inter-provincial boundary falling in them, regarding which orders of the Local Government are awaited.

Jhānsi Survey Detachment.

Officer in Charge.— { Mr. P. A. T. Kenny, O.B.E., from 7-12-26 to 16-3-27.
 { Mr. J. C. C. Lears, from 1-10-26 to 6-12-26, and from 17-3-27.

114. General.—This detachment was employed on 1 inch = 1 mile survey in sheets 54 O and P, in the United Provinces and Central India, with field headquarters at Nowgong, Central India.

115. Personnel.—The field strength of the detachment consisted of 2 Class II officers, 2 Upper Subordinate Service officers and 32 Lower Subordinate officers, distributed as under:—

Mr. J. C. C. Lears (Class II), *Camp (1)*, 9 surveyors.

Mr. O. D. Jackson (Class II), *Camp (2)*, 9 surveyors and 1 pupil.

Mr. Sajawal Khan (U. S. S.), *Camp (3A)*, 4 surveyors and 1 pupil.

Mr. Jagannath (U. S. S.), *Camp (3B)*, 6 surveyors and 2 pupils.

116. Areas surveyed.—The detachment surveyed a total area of 2,970 square miles on the scale of 1 inch = 1 mile, of which 1,078 square miles consisted of original survey in sheets 54 O and P, mainly in the Jhānsi and Hamirpur districts of the United Provinces, in Nowgong in the Bundelkhand Agency and in the Orchhā, Charkhārī and Chhatarpur States of Central India. The remainder consisted of 1,892 square miles of resurvey in the north half of sheet 54 P, covering parts of the States of Orchhā, Bijāwar, Charkhārī and Chhatarpur of Central India.

A total area of 538 square miles of supplementary triangulation was executed in sheet 54 O.

117. Topographical surveys.—

Camp (1), under Mr. J. C. C. Lears, carried out original survey and resurvey in an area of 961 square miles in sheet 54 P. Mr. Sajawal Khan was in charge of this Camp at the beginning of the field season and Mr. Jagannath at the end, for short periods, during which Mr. Lears held charge of the detachment.

Camp (2), under Mr. O. D. Jackson, completed 1,081 square miles of resurvey in sheet 54 P.

Camp (3) was in charge of Mr. Jagannath when the field season commenced, but early in December this Camp was subdivided into two sections, (3A) and (3B). Mr. Sajawal Khan was placed in charge of the former which surveyed an area of 359 square miles of original survey in 54 O, and Camp (3B) under Mr. Jagannath completed 569 square miles of original survey in sheets 54 O and P.

Of the 32 surveyors in the detachment 16 had been temporarily transferred to it for training. Three of the remaining surveyors were employed as instructors for 2 months at the beginning of the field season, and three others joined the detachment in the middle of January from No. 22 Party. These special circumstances account for the comparatively small out-turn for the season.

The triangulation data for the north half of 54 P was extracted from the chart of this degree sheet published in 1914. Difficulty was experienced here with all the intersected points, which were at variance

with their plotted positions. A reference to the computation volumes showed that the values of these points had apparently not been computed, and it is surmised that their spherical values on the chart had been obtained roughly only, from paper measurements.

118. Triangulation.—Triangulation for supplementary points was carried out in sheet 54 O by Mr. Jagannath, over an area of 538 square miles, covering parts of the districts of Jhānsi and Hamīrpur of the U. P.

119. Special surveys.—In the Bāndā and Jhānsi Forest Divisions of the Eastern Forest Circle, U. P., an area of 10 square miles of reserved forests was surveyed on the 1 inch = 1 mile scale during the season.

120. Miscellaneous.—A place of great public importance and archæological interest in the Chhatarpur State is the magnificent series of Brāhminical and Jain temples known as the Khajrāho temples, named after the ancient town of Khajrāho near which they stand. Their construction has been assigned to dates between the 9th and 11th centuries. Built of sandstone and gneiss, the carvings on some are exquisite and exceedingly rich and cover every inch of available space. The epigraphical records contained in them are of great historical interest. There is an annual religious fair held at the temples during March, which is attended by pilgrims from all parts of India.

121. Recess duties.—The fair-mapping of the field work was divided into two sections. Mr. O. D. Jackson, with Mr. Sajawal Khan to assist him, was placed in charge of one, and Mr. Jagannath, assisted by surveyor Ram Saran was responsible for the other. The mapping of all field work was completed during the year.

VII.—SURVEY REPORTS, SOUTHERN CIRCLE.

DIRECTOR:—Lt.-Col. C. M. Browne, C.M.G., D.S.O., R.E.

122. Summary.—The units administered by the Southern Circle during the year were Nos. 6, 7 and 8 Parties and No. 4 Drawing Office.

123. Training.—Twenty-one pupil surveyors were attached to No. 7 Party during the field season and 8 new pupils were entertained in recess 1927.

124. The field work of Parties was as follows:—

No. 6 Party.—Topography on the scale 1 inch = 1 mile in sheets 56 I, M, N and 47 M. Revision of the three-inch map of Secunderābād and Bolārum; guide maps of the Ellora and Ajanta Caves.

No. 7 Party.—Topography on the scale 1 inch = 1 mile in sheets 57 A, E and F. Sixteen-inch special surveys of estates in sheet 48 O.

No. 8 Party.—Topography on the scale 1 inch = 1 mile in sheet 58 E. Four-inch forest surveys in sheet 46 H and sixteen-inch surveys of estates in sheets 58 B and C.

No. 6 Party.

Officer in charge.—{ Major R. S. Wauchope, O.B.E., I.A., from 12-11-26.
Mr. E. A. Meyer to 11-11-26.

125. General.—The party carried out topographical surveys in the Central Provinces and Hyderābād State on the scale of 1 inch = 1 mile and also demarcated areas of mineral concessions. The Staff of the Secunderābād Area and the Poona District asked for certain special compilations of maps to be done, which required revision of half-inch work on the scale of 1 inch = 1 mile.

The field headquarters of the party were at Pēddapalli till the 10th February 1927 when they had to be closed owing to scarcity of water, which was abnormal this year; they were reopened at Secunderābād from the 13th February 1927.

126. Personnel.—The field strength of the party numbered 3 Class II officers, 4 Upper Subordinate officers and 36 Lower Subordinate officers, distributed as under:—

Major R. S. Wauchope, O.B.E., I.A., *Camp (4)*, 5 surveyors.

Mr. E. A. Meyer (Class II), with assistance of Mr. Muhammad Abdul Azim, I.D.S.M. (U. S. S.), *Camp (1)*, 9 surveyors.

Mt. E. N. Natesan, B.A. (Class II), with assistance of **Mr. J. A. Cabral (U. S. S), Camp (2),** 1 U. S. S. officer and 9 surveyors.

Mr. C. P. E. Davenport (Class II), Camp (3), 9 surveyors.

127. Areas surveyed.—This party completed an area of 3,839 square miles of original and 239 square miles of revision survey on the scale of 1 inch = 1 mile in Chānda district of the Central Provinces (sheet 56 M) and the Adilābād and Karimnagar districts of Hyderābād State (sheets 56 N and I). It also carried out 1,007 square miles of revision survey on the scale of 1 inch = 1 mile round Aurangābād (sheet 47 M) for the military authorities and 45 square miles of revision survey on the scale of 3 inches = 1 mile of the Secunderābād and Bolārum military map.

128. Topographical surveys.—*Camp (1)*, under **Mr. E. A. Meyer**, carried out 1 inch = 1 mile original survey in sheet 56 M/S.W. The adoption of this scale instead of the half-inch for the whole area is due to the fact that it contains large areas of forests which will eventually be produced for H. E. H. the Nizām's Forest Department on the scale of 2 inches = 1 mile. It has been found more satisfactory in such circumstances to survey the whole of the sheet on the larger scale than to have frequent changes of scale from one-inch to half-inch.

Camp (2), under **Mr. E. N. Natesan, B.A.**, carried out work in the south of Chānda of the same class and scale as that carried out by *Camp (1)*, including a certain amount of revision work reduced from the four-inch forest survey.

Camp (3), under **Mr. C. P. E. Davenport** did similar work to *Camp No. 2* in the Adilābād district.

Camp (4), directly under the Officer in charge of the party, undertook various items *viz.*, surveys for special guide maps of Ellora and Ajanta on the large scale of 1 inch = 250 feet (this scale was chiefly adopted in order to coincide with the scale adopted by James Burgess in the surveys of the interior of the caves); revision survey for the military authorities, and demarcation of boundaries for mineral concessions by fixing points either by triangulation or resection.

There was a certain amount of delay in surveyors getting actually to their areas owing to difficulties in communications and the long march from Peddapalli, which was in some cases as much as six days' journey.

129. Miscellaneous.—Negotiations are being carried out with H. E. H. the Nizām's Government, and are proceeding favourably, with regard to this party taking over certain traverse work for them.

In certain areas west of Asifābād many villages recorded on the old quarter-inch sheets have now been evacuated and on investigation it was found that this chiefly happened during the influenza epidemic of 1918-21 when villages, of which the huts only consisted of grass and bamboo, were either wiped out or moved to other inhabited sites. In the country between Adilābād and Rājūra in the time of the old Gond kingdom of Mānikgarh there must have been quite a considerable population where now the country is very sparsely populated. There are many remains of old Jain buildings and fortified villages. Stone circle burials, as found in many other parts of the state, were not located except 15 miles north-west of Peddapalli where there is one large cemetery.

130. Recess duties.—During recess Messrs Natesan, Davenport and Muhd. Abdul Azim have been chiefly responsible for the fair mapping, and have been assisted by Messrs Cabral and Muthanna.

Mr. Meyer was early transferred to No. 8 Party of which he took charge.

It is expected that the fair sheets will be completed before the party takes the field.

12 two-inch special forest maps for H. E. H. the Nizam's Government have been drawn in the party.

No. 7 Party.

Officer in charge.— $\left\{ \begin{array}{l} \text{Major H. T. Morshead, D.S.O., R.E., to 8-11-26.} \\ \text{Mr. S. S. McA'Fee Fielding from 9-11-26 to 30-6-27.} \\ \text{,, V. W. Morton from 1-7-27.} \end{array} \right.$

131. General.—The party was employed on topographical surveys on the scale of 1 inch = 1 mile in Madras, Madras States, Hyderābād and Mysore (sheets 57 A, E and F); also on special survey of tea and coffee estates in Mysore, on the scale of 16 inches = 1 mile, in sheet 48 O. The field headquarters of the party remained at Bangalore.

132. Personnel.—The field strength of the party numbered 1 Class II Officer, 4 Upper Subordinate Service Officers, and 36 Lower Subordinates distributed as under:—

Mr. V. W. Morton (Class II), *Camp (1)*, 7 surveyors and 5 pupils.

Mr. K. G. Mandanna (U. S. S.), *Camp (2)*, 1 U. S. S. officer, 5 surveyors and 4 pupils.

Mr. Abdul Ghafur (U. S. S.), assisted by surveyor Ghulam Rasūl Khan (Instructor), *Camp (3)*, 12 pupils.

Three surveyors were employed on the sixteen-inch surveys of tea and coffee estates and were directly under the supervision of the Officer in Charge.

During the field season one U. S. S. officer was transferred to No. 8 party, one surveyor to the Nepāl Survey Detachment and one surveyor to foreign service connected with the Turco-Iraq Boundary Delimitation Commission.

133. *Areas surveyed.*—4,970 square miles of original survey on the scale of 1 inch = 1 mile were carried out in Anantapur, Bellary and Kurnool districts of Madras, Sandūr State of Madras States, Raichūr district of Hyderābād State, and Chitaldrug and Tumkūr districts of Mysore State, in sheets 57 A, E and F. Also 4,178 acres on the sixteen-inch scale in Kadūr district of Mysore State in sheet No. 48 O.

134. *Topographical surveys.*—*Camp (1)*, under Mr. V. W. Morton, surveyed 2,099 sq. miles on the scale of 1 inch = 1 mile in sheets 57 A and F.

Camp (2), under Mr. K. G. Mandanna, surveyed 1,727 sq. miles on the scale of 1 inch = 1 mile in sheet 57 F.

Camp (3), under Mr. Abdul Ghafur, surveyed 1,144 sq. miles on the scale of 1 inch = 1 mile in sheet 57 E.

The country consisted chiefly of open undulating plains, with low rocky hills here and there. In the neighbourhood of Bellary and in Sandūr State the hills were higher and of more regular formation but were generally destitute of trees. The surveyors experienced a good deal of difficulty, from scarcity of water especially during the hot weather. A partial famine was declared in parts of Bellary and Anantapur districts owing to the failure of the previous monsoon.

135. *Special surveys.*—An area of about 4,178 acres of tea and coffee estates was surveyed on the sixteen-inch scale in sheet 48 O. This work was slow and laborious owing to the very steep and heavily wooded hills on which the estates lie.

Points were fixed for the use of the 12th Brigade R. F. A. in the neighbourhood of Hoskote, a few miles out of Bangalore.

136. *Miscellaneous.*—There were several places of archæological interest in the area under survey; many of the hills were crowned with ancient forts—some, as in Adoni, Bellary and Pāvugada being in a remarkable state of preservation. Mention must also be made of the ruins of Hampi, the site of the capital of the old kingdom of Vijayanagar; the roads leading to and among these ruins are shown on the twelve-inch map prepared by the Madras Revenue Surveys.

The health of the party was generally good though one surveyor had to be invalided owing to malaria. The surveyors working on the tea estates suffered a good deal from the fever for which the Malnād is notorious.

137. Recess duties.—The fair mapping of all field work was completed during the year by three sections under Messrs N. S. Harihara Iyer (Class II) who was transferred to the party from No. 4 Drawing Office on 1st July 1927, K. G. Mandanna (U. S. S.) and Abdul Ghafur (U. S. S.).

During recess 1927, seven pupil-surveyors were posted to this party for training under surveyor Ghulam Rasul Khan (Instructor).

For the mapping of the sixteen-inch estate maps, as on previous occasions, 2 traces were prepared of each, one contour and one outline; all necessary typing was done on the traces, as prints in only two colours (black and brown) were required.

Eight sheets of last season's mapping were still in hand when the party took the field, and were completed in January 1927. Mr. Shib Lal (U. S. S.), who had been detailed for the extension of the Cauvery (Mettūr) survey, which had been asked for by the Irrigation Department and was afterwards abandoned, had charge of these sheets.

No. 8 Party.

Officers in charge.— $\left\{ \begin{array}{l} \text{Major L. H. Jackson, I. A., to 21-4-27.} \\ \text{Mr. F. C. Pilcher from 22-4-27 to 30-6-27.} \\ \text{Mr. E. A. Meyer from 1-7-27.} \end{array} \right.$

138. General.—This party completed the topographical survey on the scale of 1 inch = 1 mile of sheet 58 E in Madras and Mysore; forest surveys on the 4 inches = 1 mile scale in 46 H in Bombay and surveys of private estates on the 16-inch scale in 58 B and C in Madras and the Madras States.

The sphere of operations of the whole party, except the small detachment on the four-inch forest surveys, was changed from Bombay to Madras, with field headquarters at Coimbatore.

139. Personnel.—The field strength of the party numbered 4 Class II officers, 4 Upper Subordinate Service officers and 45 Lower Subordinate officers, distributed as under:—

Mr. F. C. Pilcher (Class II), *Camp (1)*, 8 surveyors to 28th February, and thereafter *Camps (1) and (5)*, 11 surveyors, up to 22nd April when this officer assumed charge of the party.

Mr. B. T. Wyatt (Class II), *Camp (2)*, 13 surveyors, traverser and computer, was in charge of special large-scale surveys of private tea and rubber estates.

Mr. M. S. Ganesa Aiyar (Class II), *Camp (3)*, 12 surveyors.

Mr. S. R. Kelkar, B.Sc., (Class II), *Camp (5)*, 3 surveyors to 28th February; thereafter this officer was employed on triangulation.

Mr. Shib Lal, R.S., (U. S. S.), *Camps (1) and (5)*, 11 surveyors, from 22nd April.

Mr. Saiyid Budhan (U. S. S.), *Camp (4)*, 4 surveyors, was in charge of four-inch forest surveys.

Mr. H. Narasimhamurti Rao, B.A. and Mr. P. S. Vengusvami (U. S. S.) undertook triangulation and traversing.

140. Areas surveyed.—3,168 square miles of original survey and 1,421 square miles of revision survey (excluding 69 square miles of special four-inch survey) were completed on the 1 inch = 1 mile scale in the Coimbatore, Nilgiri, Salem and Trichinopoly districts of Madras, and Mysore district of Mysore State, in sheet 58 E. Also 47.5 square miles of forest survey on the 4 inches = 1 mile scale in the West Nāsik Forest Division, Bombay, in sheet 46 H, and 14,607 acres (22.82 square miles) of special surveys of private tea and rubber estates on the 16-inch scale in the Coimbatore district of Madras, and Travancore State, were surveyed.

78 linear miles of traversing, and 4,382 square miles of triangulation, both in advance for detail survey on the one inch scale, were completed; also 63.5 square miles of triangulation and 4.9 linear miles of traversing for the special estates survey.

141. Topographical surveys.—*Camp (1)*, under Mr. F. C. Pilcher to April and subsequently under Mr. Shib Lal, R.S., completed on the scale of 1 inch = 1 mile in Madras, 1,192 square miles of original and 485 square miles of revision survey. An area of 69 square miles, specially surveyed the previous season on the four-inch scale by No. 7 party in connection with the Cauvery (Mettūr) project, was reduced to the scale of survey for incorporation with this work.

Camp (3), under Mr. M. S. Ganesa Aiyar, completed 1,393 square miles of original and 936 square miles of revision survey on the scale of 1 inch = 1 mile in Madras and Mysore. One surveyor also carried out corrections and surveyed a new railway line, both in the adjoining sheet, 58 A.

The country surveyed by these two camps consisted of fairly heavily wooded heights and foothills, and undulating cultivated plains thickly covered with palmyra and cocoanut palms, thorny trees and cactus hedges, with a few isolated, bare, rocky hills scattered over the northern and central portions.

Camp (5) under Mr. S. R. Kelkar, B.Sc. to February, Mr. F. C. Pilcher from 1st March to 21st April, and then under Mr. Shib Lal, R.S. completed 583 square miles of original survey on the scale of 1 inch = 1 mile in sheet in Madras. The country surveyed by this camp comprised a few low detached hills covered with light scrub, and undulating, cultivated plains similar to the other camps. Most of the ground in the southern portion under camps (3) and (5) had to be surveyed by plane-table traverse, which naturally delayed its completion.

There was practically no cold weather, and the months of April and May were excessively hot, though there were a few storms in the early part of the latter.

Camps (2) and (3) had to cover distances of over 40 miles to their areas, but difficulties were obviated by motor buses.

142. *Triangulation.*—In Madras and Pudukkottai State in sheet 58 J, was commenced from a base of the Madura Series of 1916-17 and closed on a base of the Great Arc Series, Section 8° to 18° of 1840-74. The trestle stations of the South-East Coast Series were evidently not observed from.

143. *Traversing.*—Owing to the unsuitability of the country for triangulation in the Rāmnād and Tanjore districts and Pudukkottai State in the south-east corner of 58 J, points had to be fixed by traverse. This impeded the triangulation mentioned above.

144. *Computing and Compiling Section.*—During October and November 1926 the computing section under Mr. S. R. Kelkar, assisted by surveyors from drawing sections, made on Bristol boards, (for the preparation of field sections in blue), prints from four-inch forest reductions and one-inch Madras Revenue Survey sheets, and also the data for plotting. The details shown on these field sections were checked during the field season.

145. *Special surveys.*—Several private tea and rubber estates were surveyed on the 16-inch scale with 25-feet contour intervals, by camp (2) under Mr. B. T. Wyatt who, with a surveyor to assist him, went out in advance of his camp to provide data for the detail survey by triangulation and traversing. To avoid any delay the estates left over for next season were triangulated in advance by Mr. S. R. Kelkar.

At the request of the Chief Conservator of Forests, Bombay, several small areas acquired by the Forest Department were surveyed by Camp (4) on the scale of 4 inches = 1 mile under Mr. Saiyid Budhan. These areas had been left over from the previous season.

146. *Miscellaneous.*—Several herds of wild elephants, with a few

rogues, were seen in the forests in the northern hills of 58 E but fortunately no one met with any mishap. Special arrangements had to be made for three or four men of the Sholga hill forest tribe to accompany surveyors when camped in the heart of the forests, where it was very difficult to obtain supplies and labour.

Practically all isolated hills in the plains of 58 E, have upon them at least one temple of both archæological and historical interest with broad stone steps leading to the summits.

The health of the party was not all that could be desired; seven surveyors fell seriously ill, and had to be sent on medical leave.

147. Recess duties.—Fair sheets were drawn by three sections under Messrs Pilcher, Wyatt and Ganesa Aiyar and computations were dealt with by a section under Mr. P. S. Vengusvami assisted by Mr. H. Narasimhamurti Rao. The fair mapping of 6 sheets was completed by the end of the survey year, leaving 14 sheets which will be submitted before the party takes the field.

16-inch estates mapping was carried out as follows; contour sheets were fair-drawn on drawing blue prints for fair originals and contour values typed; headings, names, etc., were correctly typed on similar prints in black which served as outline fair sheets. 6 estates have been fair mapped and the remaining 10 will be completed shortly.

The four-inch forest survey field sections were sent to the Forest Map Office for fair mapping.

VIII.—SURVEY REPORTS, EASTERN CIRCLE.

DIRECTOR:— $\left\{ \begin{array}{l} \text{Lt.-Colonel A. A. McHarg, D.S.O., R.E., up to 27-10-26.} \\ \text{Lt.-Colonel L. G. Crosthwait, I.A., from 28-10-26 to 22-4-27.} \\ \text{Major F. J. M. King, R.E., from 23-4-27 to 11-5-27.} \\ \text{Lt.-Colonel R. H. Phillimore, D.S.O., R.E., from 12-5-27.} \end{array} \right.$ •

148. Summary.—The units administered by the Eastern Circle were Nos. 4, 9 and 12 Parties, and No. 5 Drawing Office.

In addition to his duties in charge of the Eastern Circle, the Director, as Director of Surveys, Assam, held administrative charge, under the local government of the Assam Traverse Party, the Assam Drawing and Reproducing offices at Shillong, and the Assam Survey School at Jhālukbāri. Also in his capacity as technical adviser on survey matters to the Government of Bengal, he visited the Bengal Survey Office at Alipore and the Bengal Traverse Party in the field.

Office buildings.—The *Bonnie Brae* estate in Shillong has been purchased by the Government of India at a cost of Rs. 80,000 for Eastern Circle units. Rs. 1,68,000 has been approved for the construction of new office buildings on this estate, and these will shortly be put in hand by the Assam Public Works department.

149. Training.—Nine pupil surveyors were attached to field parties during the field season and eight new pupils were entertained in April 1927.

150. *The field work* of Parties covered 41 sheets partly or wholly surveyed, as follows:—

No. 4 Party.—Topography on scale 1 inch = 1 mile in sheets 73 I and 73 M.

No. 9 Party.—Topography on scale 1 inch = 1 mile in sheets 73 J and 73 K.

No. 12 Party.—Topography on scales 1 inch = 1 mile and $\frac{1}{2}$ inch = 1 mile in sheets 78 J and 78 K.

No. 4 Party.

Officer in charge.— $\left\{ \begin{array}{l} \text{Mr. C. C. Byrne, up to 16-11-26.} \\ \text{Major F. B. Scott, I.A., from 17-11-26.} \end{array} \right.$

151. General.—The party carried out supplementary survey on the scale 1 inch = 1 mile in sheets 73 I and 73 M, in Bihār and Orissa, and Bengal. The four-inch survey of the Jharia coalfield had been completed during the previous season. •

The field headquarters of the party were at Dhānbād.

152. Personnel.—The field strength of the party numbered 3 Class II officers, 3 Upper Subordinate Service officers and about 30 Lower Subordinate officers distributed as under:—

Mr. J. McCracken, M.B.E., (Class II), with the assistance of Mr. Abdul Aziz Khan (U. S. S.), *Camp (1)*, 5 surveyors and 7 pupils.

Mr. C. O. Picard (Class II), *Camp (2)*, 8 surveyors.

Lieut. C. S. McInnes (Class II), *Camp (3)*, 7 surveyors and 1 pupil.

Mr. A. C. Maulick (U. S. S.) and surveyors Hari Singh and Chintamani Mangain were employed in triangulation and computer Cheda Lal Bhatnagar in levelling.

Mr. C. O. Picard proceeded on combined leave for 1 year from 5th May 1927.

Mr. N. C. Roy (U. S. S.) was on leave on medical certificate from 11th August 1926 to 9th February 1927, and was attached to No. 5 Drawing office till the close of the field season.

One surveyor resigned and one surveyor was discharged during the field season.

153. Areas surveyed.—An area of 3,076 square miles was surveyed on the scale 1 inch = 1 mile, the whole being supplementary survey in sheets 73 I and 73 M, lying in the Hazāribāgh, Mānbhūm and Santāl Parganas districts of Bihār and Orissa, and the Bānkurā and Burdwān districts of Bengal.

An area of 4,070 square miles was triangulated in sheets 73 E and 73 I in the Hazāribāgh, Mānbhūm and Rānchī districts of Bihār and Orissa, and the Bānkurā district of Bengal.

154. Topographical surveys.—The work was divided into three camps as shown below:—

Camp (1) Mr. J. McCracken, M.B.E., in charge, mostly in Mānbhūm district with headquarters at Purūlia.

Camp (2) Mr. C. O. Picard, in charge, in the Mānbhūm and Bānkurā districts to the east of Purūlia.

Camp (3) Lieut. C. S. McInnes, in charge, in the north east of sheet 73 I round Asansol.

The country consisted of undulating cultivated ground with small patches of jungle and isolated rocky hills. The cultivated area is irrigated from numerous small tanks.

The whole area was supplementary survey carried out on scale 1 inch = 1 mile on blue-print reductions of recent 16-inch cadastral survey.

155. Triangulation.—Triangulation was carried out in sheet 73 E

and in sheet 73 I, mostly in Hazāribāgh and Rānchi districts, on the high ground of the Chotā Nāgpur plateau. Connection was made with triangulation of No. 1 Party to the west.

156. Levelling.—54 linear miles of levelling were run, to give heights to trijunction stones and other points already fixed by traverse for Local Government revenue surveys. This has been found more economical than triangulation in flat country.

157. Forest surveys.—An area of 9 square miles, included in the total party area was surveyed on the scale 1 inch = 1 mile in the Jaipur and Barābhūm reserved forests of the Chaibāsa Forest Division.

158. Recess duties.—The fair mapping was divided into two sections as given below :—

Section (1) Mr. J. McCracken, M.B.E., in charge.

Section (2) Lieut. C. S. McInnes, in charge.

The fair mapping of all field work was completed during the year.

The computing of the triangulation was under the charge of Mr. A. C. Maulick.

No. 9 Party.

Officer in charge.—Mr. B. M. Berrill.

159. General.—Topographical surveys on the scale 1 inch = 1 mile was carried out in 73 J and K in Bihār and Orissa and the Bengal Presidency. The field headquarters of the party were at Midnapore (Bengal).

160. Personnel.—The field strength of the party numbered 2 Class II officers, 5 Upper Subordinate Service officers and about 30 Lower Subordinate officers, distributed as under :—

Mr. Madras Mahadeva Mudaliar, M.A. (Class II), *Camp (1)*, 10 surveyors.

Mr. Bhupendra Nath Saha, M.Sc. (Class II), *Camp (2)*, 10 surveyors.

Mr. Dharendra Nath Saha, (U. S. S.), *Camp (3)*, 8 surveyors and 2 pupils.

Messrs B. B. Shome and R. K. Talapatra, (U. S. S.), and surveyor Hari Datta were employed in triangulation and traversing.

Mr. R. E. Saubolle (Class II) returned from leave on 22nd April 1927.

Mr. M. M. Mudaliar (Class II) left on the 4th May 1927 on transfer to Southern Circle.

161. Areas surveyed.—The party surveyed on the scale of 1 inch = 1 mile 1,867 square miles of original survey and 1,439 square miles of supplementary survey in 73 J and K, in the Mānbhūm and Singhbhūm

districts and the Feudatory States of Orissa, and in the Bānkurā and Midnapore districts of Bengal. Areas of 1,296 square miles were triangulated and 1,120 square miles traversed in sheet 73 K, in Balasore and Cūttack districts and in the Keonjhar, Mayūrbhanj and Nilgiri Feudatory States of Orissa.

162. *Topographical surveys.*—*Camp (1)* under Mr. M. M. Mudaliar, surveyed 1,105 square miles of original survey on the scale 1 inch = 1 mile in the Mayūrbhanj and Keonjhar States. The area surveyed comprised a small portion of cultivated and wooded plains, while the major portion was practically the whole of the Simlipāl hills. This group of hills, which forms a forest reserve in the Mayūrbhanj State, rises from about 300 feet to nearly 4,000 feet and presented difficulties akin to unexplored tracts. The tops of the hills are mostly flat and very densely covered with trees so that the surveyors had to build on tree tops, 'machāns' or platforms varying from 30 to 70 feet above ground. The climate is very unhealthy and this camp suffered much from malarial fever. Only a few hamlets exist on the plateau and these are occupied chiefly by *Kol* settlers, while the poorer jungle tribes known as *Kharias* have no settled homes and live mainly on the forest produce. These hills harbour big game, wild elephants principally, and their tracks together with forest lines are the only paths for moving about, except in areas under timber felling.

Camp (2) under Mr. B. N. Saha surveyed an area of 1,102 square miles partly original and partly supplementary on the scale 1 inch = 1 mile in Singhbhūm and Midnapore districts and Mayūrbhanj State.

Camp (3) under Mr. D. N. Saha surveyed an area of 1,099 square miles partly original and partly supplementary on the scale 1 inch = 1 mile in Mānbhūm, Singhbhūm, Bānkurā and Midnapore districts.

The country surveyed by camps 2 and 3 consisted of the flat cultivated and wooded plains of Bengal on the east, merging into undulating scrub jungle, low rocky hills and the higher wooded hills of Bihār and Orissa on the west.

163. *Triangulation and Traversing.*—Messrs B. B. Shome and R. K. Talapatra triangulated in the hilly area up till the end of February and then joined surveyor Hari Datta in traversing the low ground of Balasore district and Mayūrbhanj State.

Two computers were employed on traverse computations at field headquarters during the field season.

164. *Forest surveys.*—A special survey of the Simlipāl State Forest in the Mayūrbhanj State was carried out on the scale 1 inch = 1 mile,



A SURVEY "MACHAN" IN SIMLIPAL FORESTS, MAYURBHANJ STATE.
SOME OF THESE "MACHANS" WERE AS MUCH AS 70 FEET HIGH.

[See page 72]

showing inter-forest boundaries and the position of all forest bungalows and offices. A special edition of the one-inch sheets will show these additional details surprinted in a special colour.

City surveys.—A surveyor was attached to the Map Publication Office for revising the six-inch map of Calcutta.

165. Recess duties.—The fair-mapping sections were as follows:—

Section (1) Mr. R. E. Saubolle, Section (2) Mr. B. N. Saha, Section (3) Mr. D. N. Saha. The computing section was under Mr. B. B. Shome. The fair mapping of all field work was completed during the year.

No. 12 Party.

Officer in charge.—

{	Major F. J. M. King, R.E., to 20-4-27.
	Mr. E. M. Kenny, from 21-4-27 to 13-6-27.
	Major H. R. C. Meade, I.A., from 14-6-27.

166. General.—This party carried out topographical surveys on the scales $\frac{1}{2}$ inch and 1 inch = 1 mile with the necessary triangulation and traversing in Assam and Bengal, in degree sheets 78 F, J and K. The field headquarters of the party were at Gauhati.

167. Personnel.—The party, after re-absorption of the Sadiya Frontier Detachment, consisted of 3 Class II officers, 3 Upper Subordinate Service officers and 33 Lower Subordinate officers distributed as under:—

Mr. P. Simpson (Class II), *Camp (1)*, with 4 surveyors and 1 pupil.

Mr. E. M. Kenny (Class II), *Camp (2)*, with 11 surveyors.

Mr. R. C. Hanson (Class II), *Camp (3)*, with 2 Upper Subordinate Service officers, 6 surveyors and 3 pupils.

Mr. Simpson proceeded on sick leave for 4 months on the 24th March 1927, Mr. Moti Lal Roy (U. S. S.) then taking over his camp.

Mr. S. C. Chatterjee (U. S. S.) and surveyor Muhammad Akbar were employed on triangulation.

168. Areas surveyed.—1,816 square miles of original survey were surveyed on the scale 1 inch = 1 mile in Goālpāra and Kāmṛūp districts in degree sheets 78 J and K, and 936 square miles of original survey on the scale $\frac{1}{2}$ inch = 1 mile in the Gāro and Khāsi and Jaintiā Hills districts in 78 K.

An area of 5,553 square miles was triangulated and traversed in the Gāro Hills and Goālpāra districts of Assam and in Cooch Behār State, Jalpaiguri and Rangpur districts of Bengal in degree sheets 78 F, J and K.

169. *Topographical surveys.*—*Camp (1)* under Mr. P. Simpson and *Camp (2)* under Mr. E. M. Kenny carried out original survey on scale $\frac{1}{2}$ inch = 1 mile in the Goālpāra and Kāmṛūp districts, sheet 78 J.

The country surveyed by Camps 1 and 2 extends from the Bhutān border southwards to the Brahmaputra river. The country is flat with a few isolated hills in the south-west, and, except for a populous strip along the E. B. Railway line, is covered with high elephant grass and scattered *simal* trees. A great scarcity of water in the country along the Bhutān border caused much trouble. The streams which come down from the Bhutān Hills disappear on entering the plains to reappear some 5 miles further south.

Camp (3) under Mr. R. C. Hanson carried out original survey on the scale $\frac{1}{2}$ inch = 1 mile in the Gāro Hills and Khāsi and Jaintiā Hills districts and on the scale 1 inch = 1 mile in Goālpāra and Kāmṛūp districts, sheets 78 J and K.

The country surveyed extends from the Brahmaputra river southwards into the Gāro Hills. The strip of plains between the river and the hills is fairly well wooded with *sāl* trees and the Gāro Hills are forest clad.

170. *Triangulation.*—Mr. S. C. Chatterjee and surveyor Muhammad Akbar triangulated 3,021 square miles in Goālpāra and Gāro Hills districts, sheets 78 J and K.

171. *Traversing.*—Traversing for 1-inch survey was carried out under Mr. Simpson in Goālpāra district and in Cooch Behār State, and in Jalpaiguri and Rangpur districts of Bengal in sheets 78 F and J, where triangulation is impossible.

172. *Forest surveys.*—An area of 285 square miles of reserved forests were surveyed on the scale 1 inch = 1 mile in the Goālpāra and Kāmṛūp Forest Divisions. 60 square miles of reserved forests were surveyed on the scale $\frac{1}{2}$ inch = 1 mile in the Gāro Hills Forest Division.

173. *Recess duties.*—The fair mapping was carried out under the supervision of Messrs E. M. Kenny, R. C. Hanson and Moti Lal Roy. Mr. S. C. Chatterjee was in charge of the computing section.

The mapping of all field work was completed during the year.

IX.—SURVEY REPORTS, BURMA CIRCLE.

DIRECTOR:—{ Lt.-Colonel E. T. Rich, C.I.E., R.E., up to 2-5-27.
 „ L. G. Crosthwait, I.A., from 3-5-27.

174. Summary.—The units administered by the Burma Circle were Nos. 10, 11 and 21 Parties and No. 7 Drawing Office.

175. Training.—Of the pupil surveyors and draftsmen under training in the Circle, 20 made satisfactory progress and 3 were discharged as unlikely to become efficient.

In addition 12 new pupils were enlisted during recess and were attached to No. 7 Drawing Office for instruction in drawing.

176. The field work of parties was as follows:—

Nos. 10 and 11 Parties.—Topography on the scale of 1 inch = 1 mile, but including small areas on the two-inch and four-inch scales, in Lower Burma.

No. 21 Party.—Survey of reserved forests on the scales of 2 inches and 4 inches = 1 mile in the Central, Chindwin and Hlaing Forest Circles and five forest divisions.

No. 10 Party.

Officer in charge:—{ Captain G. Lennox, I.A., to 4-5-27.
 Mr. D. K. Rennick, M.B.E., from 5-5-27 to 28-5-27.
 Major F. J. M. King, R.E., from 29-5-27.

177. General.—The party continued the topographical survey of the western coast line of Burma and the country contiguous, on the scale of 1 inch = 1 mile in sheets 85 K, L and P, 86 I and M and 94 D.

The field headquarters of the party were at Bassein.

178. Personnel.—The field strength of the party numbered 3 Class II, 3 Upper Subordinate and 24 Lower Subordinate officers distributed as under:—

Mr. D. K. Rennick, M.B.E. (Class II), *Camp (1)*, with one U. S. S. Officer and 9 surveyors.

Mr. G. A. Norman, M.B.E. (Class II), *Camp (2)*, with one U. S. S. Officer and 11 surveyors.

Captain F. E. R. Calvert (Class II), *Camp (3)*, with one U. S. S. Officer and 4 traversers.

179. Areas surveyed.—The party surveyed a total area of 3,060 square miles and carried out traverse over an area of 1,965 square miles in the Bassein, Hanthawaddy, Ma-ubin, Myaungmya and Pyapon,

districts of the Irrawaddy delta, falling in Sheets Nos. 85 K, L and P, 86 I and M and 94 D.

The area surveyed comprised 2,418 square miles of original and supplementary survey and 580 square miles of revision survey on the scale of 1 inch = 1 mile, and 62 square miles of reserved forest on the scale of 2 inches = 1 mile.

180. Topographical surveys.—*Camp (1)* under Mr. D. K. Rennick, M.B.E., carried out original, supplementary, and revision survey of 1,464 square miles on the scale of 1 inch = 1 mile; and 2 square miles of reserved forest on the scale of 2 inches = 1 mile.

Camp (2) under Mr. G. A. Norman, M.B.E., carried out original, supplementary and revision survey of 1,534 square miles on the scale of 1 inch = 1 mile, which included part of the air survey of the Irrawaddy delta of 1923-24; and 60 square miles of reserved forest on the scale of 2 inches = 1 mile.

The area was on the whole difficult, embracing the broken west and south-west coast line of Burma, the wooded Arakan Yomas and the cultivated, creek-intersected country of the Irrawaddy delta.

In the dense forests of the Arakan Yoma, *machans* built on the tops of lopped trees were employed with great success. They were used owing to the immense size of the trees and the undefined features of the hills, where clearing for interpolation by resection was found tedious and laborious.

181. Traversing.—*Camp (3)* under Captain F. E. R. Calvert ran a main traverse line of 127 miles from Tagaung Pagoda Station (Bassein) of the Burma Coastal Series (Minor G. T.) to Lekheik Station of the New Minor Series, triangulated by No. 15 Party in 1926-27. The closing error of this line was 1/737 in Easting and 1/3777 in Southing. Several stations of the old minor series in the Hanthawaddy and Pyapon districts were connected by traverse, revealing a difference of 1.44 chains in Easting and 1.61 chains in Southing between the old and new triangulation series.

A network of traverse of 872 linear miles based on the main traverse, covering an area of about 1,965 square miles in Bassein, Myaungmya, Ma-ubin, Pyapon and Hanthawaddy districts of the Irrawaddy delta and falling in sheets 85 P, 86 M and 94 D was completed.

182. Special surveys.—In the Delta Forest Division 62 square miles were surveyed on the scale of 2 inches = 1 mile, comprising the Lebyauk and Kyaukkon reserved forests.

183. Miscellaneous.—In the early part of the field season leeches were abundant throughout the area, and in some areas throughout the season. A greater nuisance, however, was the prevalence of ticks, particularly in the forest areas. Insect pests were generally troublesome.

The water supply in the lower portions of the Delta was both bad and scanty, particularly in the area traversed this season. Tanks, with accumulated rain-water, being the only supply in some tracts, bowel complaints were frequent.

The prevalence of cholera, the scourge of the Delta, was successfully combated by the preventive inoculation of the whole personnel of the party; only two deaths amongst the *khalassis* occurred from this disease. Six other *khalassis* died, one of whom was killed by a wild elephant.

The site of old Dalhousie, on the Bassein River, which was one of the early British settlements after the British annexation of the Delta has now only a few tanks marking the site.

Hainggyi, on the island of the same name at the mouth of the Bassein River, a trading settlement of the East India Company in 1687 and the scene of a massacre of the British population in 1759, has an old wall about 25 feet high still standing, apparently a corner of the fort; in this is inset a memorial tablet of comparatively recent date.

184. Recess duties.—The mapping of the fifteen fair sheets on the scale $1\frac{1}{2}$ -inches = 1 mile and of the Lebyauk and Kyaukkon reserved forests on the scale of 2 inches = 1 mile, which was completed during the recess, was divided into two sections under Mr. D. K. Rennick and Captain F.E.R. Calvert.

A computing section under Mr. Ram Prasad, R.S., satisfactorily completed the traverse computation.

No. 11 Party.

Officer in charge:—{ Lt.-Col. L. G. Crosthwait, I.A., to 11-10-26.
Major J. H. Williams from 12-10-26.

185. General.—Topographical surveys mostly on the scale of 1 inch = 1 mile were continued in the Tenasserim division of Burma in sheet No. 94G. A detachment worked in Maymyo and environs.

The field headquarters of the party were at Thaton.

186. Personnel.—The field strength of the Party numbered 3 Class

II officers, 5 Upper Subordinate Service officers, and 28 Lower Subordinates, distributed as under:—

Mr. G. E. R. Cooper, *Camp (1)*, with 1 U. S. S. officer and 7 surveyors.

Mr. A. V. Dickson, *Camp (2)*, with 7 surveyors and 1 pupil.

Mr. A. F. Murphy, *Camp (3)*, with 1 U. S. S. officer and 7 surveyors.

U. Po Kyi (U. S. S.), *Camp (4)*, with 6 pupils under training.

Mr. Hayat Muhammad, K. S. (U. S. S.) and 1 surveyor were employed on the Maymyo Guide map.

Mr. Khan Muhammad (U. S. S.) with 1 surveyor and 1 traverser carried out triangulation and traverse.

187. Areas surveyed.—The party surveyed a total area of 2,646 square miles, comprising 2,603 square miles on the scale of 1 inch = 1 mile, 2 square miles of reserved forest on the scale of 4 inches = 1 mile, in parts of the Salween, Thaton and Toungoo districts falling in sheet No. 94 G, and 41 square miles of the Maymyo Guide Map.

188. Topographical surveys.—*Camp (1)*, under Mr. G. E. R. Cooper, surveyed an area of 918 square miles on the one-inch scale, and Extension No. II of the Kyundaung reserved forest of the Thaton forest division, 2 square miles, on the four-inch scale.

Camp (2), under Mr. A. V. Dickson, surveyed 848 square miles on the one-inch scale.

Camp (3), under Mr. A. F. Murphy, surveyed an area of 837 square miles on the one-inch scale.

Of the area surveyed by these three camps on the scale of 1 inch = 1 mile about 244 square miles were covered by old forest survey maps, or maps compiled from old cadastral surveys. These maps were not contoured and were not always accurate, but where possible use was made of them. The country varied from hills of 6,900 feet to the low valleys along the Salween, Bilin and Yunzalin rivers, where the jungle was very dense and a great deal of plane-table traversing was necessary. Large areas of old *taungya* greatly impeded the movements of surveyors.

The international boundary between Burma and Siam follows part of the Salween and Thaungyin rivers.

Camp (4).—This camp was formed under U. Po Kyi for the training of 6 pupils of whom 3 belonged to No. 10 Party. With the exception of one, who was discharged, they made satisfactory progress.

189. Triangulation and Traverse.—An area of 2,120 square miles in the Insein, Pegu and Thaton districts falling in sheet 94 C was trian-

gulated by Mr. Khan Muhammad and surveyor L. M. Ganguli.

The triangulation was supplemented by 92 linear miles of traverse and was connected with the Burma Coast Series No. 52. As this series was being re-observed by the Geodetic Branch the triangulators were able to use the observation trestles which had been erected by No. 15 Party.

In the flat cultivated area between the foot-hills and the Gulf of Martaban the sides of the triangles were from 2 to 4 miles and progress was slow. The results, however, were satisfactory, and a large number of points were fixed.

190. *Special surveys.*—Maymyo Guide Map.—The survey of Maymyo and surrounding country, covering an area of 41 square miles, was completed on the scale of 4 inches = 1 mile by Mr. Hayat Muhammad and 1 surveyor. Old 16-inch maps were available for 25 square miles of this area, and were reduced to the four-inch scale but required a great deal of supplementary work owing to developments and changes around Maymyo.

The old maps surveyed between 1899 and 1912 of nine reserved forests in the Salween and Thaton Forest Divisions were brought up to date as regards boundaries and pillars, roads, rest-houses, &c. The work was done on blue prints on the scale of the original survey; these were sent to the Forest Map Office for correcting the original fair sheets.

191. *Miscellaneous.*—There was an outbreak of cholera during January and February. Some surveyors having to be recalled several days march in order that the establishments of Camps (2) and (3) might be inoculated with anti-cholera vaccine, considerably delayed the work.

There were 13 deaths from cholera and 3 from fever.

On the west bank of the Salween river a band of seven dacoits attacked and robbed four *khalassis* carrying money, killing two men and seriously wounding the other two.

As in previous years the party employed Yunnanese mules for transport. One of the drivers was killed by a tiger.

192. *Recess duties.*—The mapping of the ten fair sheets, which was completed during the recess, was divided into three sections under Messrs G. E. R. Cooper, A. V. Dickson and A. F. Murphy.

Extension II of the Kyundaung reserved forest was added to the old original fair sheet of this reserve.

Mr. Hayat Muhammad, assisted by Mr. Khan Muhammad, and Surveyor L. M. Ganguli, satisfactorily completed the triangulation and traverse computations.

No. 21 (Burma Forest) Party.

Officer in charge—Mr. J. O. Greiff.

193. General.—The *raison d'être* of the party is the survey of reserved forest areas in Burma, on scales larger than the one-inch. The total cost of the party is debitable to the Government of Burma. The party surveyed reserved forests in degree sheets 83 P, 84 M and P, 85 M, N, 93 C and D.

The field headquarters of the party were at Meiktila.

194. Personnel.—The field strength of the party numbered 2 Class II. Officers, 3 Upper Subordinate Service officers and about 32 Lower Subordinate Service officers, distributed as follows:—

Mr. L. B. Fitz-Gibbon (Class II), and Mr. P. C. Sen Gupta (U.S.S.),
Camp (1), 11 surveyors.

Mr. H. M. Critchell (Class II), and Mr. G. S. Bagchi (U. S. S.),
Camp (2), 10 surveyors and one pupil.

Mr. Bhamba Ram (U. S. S.), *Camp (3)*, six surveyors and one pupil.

Mr. J. O. Greiff in addition to his executive duties, held charge of *Camp (4)* with 3 surveyors and one pupil.

195. Area surveyed.—The total area surveyed on all scales was 509 square miles, including 16 square miles of resurvey on the scale of 4 inches = 1 mile falling in three Forest Circles and five Forest Divisions.

Central Forest Circle.—In the *Yamethin Forest Division* an area of 129 square miles, on the scale 2 inches = 1 mile was surveyed in the Byingye, Natma, Nyaunggaing reserves, and 8 square miles of unclassified forest land adjoining these to show villages and communications.

In the *Meiktila Forest Division* an area of 176 square miles, on the scale 2 inches = 1 mile, was surveyed in the following reserves:—Pyetkaywetaung, Taunggyegôn, Sindaung, and Kubyin Extensions I and II. 22 square miles on the scale 4 inches = 1 mile were surveyed in the Meiktila Fuel, Popa Hill and Popa (Extensions A, B and C) reserves; also 23 square miles of unclassified forest land adjoining these reserves.

In the *Magwe Forest Division* an area of 77 square miles was surveyed, on the scale 2 inches = 1 mile, in the Myindê, Sitha, and Myothit reserves, and 36 square miles on the scale 4 inches = 1 mile in the Kyaukmigyaung West Extension, Yaba West Extensions I and II, and Gyogyang reserves, and 3 square miles of unclassified forest land adjoining the Myothit reserve.

Hlaing Forest Circle.—In the *Prome Forest Division* 19 sq. miles on the scale 4 inches = 1 mile was surveyed in the Tōnyē Fuel reserve.

Chindwin Forest Circle.—In the *Mu Forest Division* 16 sq. miles, on the scale 4 inches = 1 mile, was resurveyed in the Nanhlaing reserve.

196. *Distribution of work.*—*Camp (1)*, under Mr. L. B. Fitz-Gibbon, carried out the work in the Mu Division.

Camp (2), under Mr. H. M. Critchell, worked in the Meiktila and Yamethin Forest Divisions.

Camp (3), under Mr. Bhamba Ram, worked in the Magwe Forest Division.

Camp (4), under the Officer in charge of the party, surveyed the detached areas in the Meiktila and Prome Forest Divisions.

The country surveyed was scattered over seven districts, and varied from high hills, in the Yamethin and Meiktila Forest Divisions rising from 3,000 feet to 6,250 feet in elevation, to undulating uplands and plains in the Magwe and Prome Forest Divisions. The former are densely wooded and rocky, the latter open, but cut up by numerous small water courses.

Popa Hill was the most noticeable feature in the Myingyan district. It is a conspicuous conical eminence 4,982 feet high, and is in fact an extinct volcano. The peak is bare, but the slopes are densely wooded with forest growth and garden holdings.

The whole area surveyed is comparatively well served by roads and railways.

197. *Triangulation.*—120 square miles of supplementary triangulation was done by *Camp (1)* in degree sheets 93 O and P, to provide points on which to close theodolite traverses.

198. *Traversing.*—485 linear miles of forest boundary theodolite traversing, and 57 linear miles of interior and connection traversing, was carried out by *Camp (1)* to provide data for the ensuing field season. This falls in sheets 83 P and 84 M and in three Forest Divisions, distributed over two Forest Circles.

The traverses were connected with stations of the Manipur Longitudinal and the Mandalay Meridional Series, and with several stations of the tertiary triangulation done by No. 10 party between 1900—1918.

199. *Special surveys.*—At the special request of the Divisional Forest Officers, small holdings and exclusions within the reserves were surveyed on the scale 8 inches = 1 mile. In the Popa Hill reserve there are about a hundred of such holdings, too small for survey on the

four-inch scale. These surveys on the eight-inch scale will be reduced by photography and transferred on to the final four-inch map of the reserves.

Recess duties.—The fair mapping was divided between two sections under Mr. L. B. Fitz-Gibbon and Mr. H. M. Critchell.

All computing work was under the charge of Mr. P. C. Sen Gupta.

At the express wish of the Conservator Working Plans Circle, certain Forest Reserves and Extensions adjoining reserves previously surveyed, have been combined with the old work and mapped on the old fair originals, so as to provide fewer and more compact maps of adjacent reserves.

X.—MISCELLANEOUS SURVEY REPORTS.

200. This section includes all Reports of surveys not administered by the Directors of the five survey circles, such as miscellaneous surveys and commercial levelling administered by the Director, Geodetic Branch, or extra-departmental explorations, etc., in which members of the Department have taken part.

No. 20 Party (Cantonment Surveys).

Officer in charge.—Mr. M. C. Petters.

201. *General.*—The party carries out original and revision surveys of cantonments and military lands as required by the Engineer-in-Chief, and prepares the results for publication. It also incorporates on the originals and office copies of existing cantonment maps the changes in buildings, roads, boundaries, etc., communicated annually by the Commanding Royal Engineers of districts, so as to have up-to-date materials for the publication of new editions when required.

The permanent headquarters of the party are at Dehra Dūn, under the administration of the Director, Geodetic Branch; field headquarters were at Quetta during the survey of Fort Sandeman cantonment and at Lahore for the survey of Lahore, Amritsar and Multān cantonments.

202. The field strength consisted of 10 surveyors and 1 computer under the supervision of Mr. J. M. Mukerji (U.S.S.) and carried out the following work:—

Surveys.—The cantonments of Fort Sandeman, Lahore including Chak Bhaikewāl, Multān and Amritsar, representing an area of 15,335 acres were revised on the scale of 16 inches=1 mile.

Traversing.—To supply data for the detail survey, 100·01 linear miles of theodolite traversing were carried out; the closing error was 0·6 per 1,000.

Levelling.—Lines of level aggregating 57·39 linear miles were run at suitable intervals in the cantonments as the control on which contouring at 5 feet vertical intervals was based. The average error amounted to 0·3 inches per mile.

203. *Recess Duties.*—The fair maps of Rāwalpindi (10), Ferozepore (4), Loralai (2), Chaman (4), Fort Sandeman (2), Lahore (2) and Quetta (8) cantonments, a total of 32 sheets, on the scales of 16 inches and 12 inches=1 mile, were completed for publication under the supervision of Mr. A. B. Hunter (Class II) assisted by draftsman Ashik Husain. In addition, the annual corrections supplied by Commanding Royal Engineers

of districts affecting 233 sheets falling in 93 cantonments were entered on the office copies and originals of the plans concerned.

No. 17 Party (Levelling).

Officer in charge.—{ Lt.-Colonel V. R. Cotter, I.A., up to 30-4-27.
Mr. N. R. Mazumdar, from 1-5-27.

204. General.—The party is responsible for all geodetic levelling, (see p. 14) and also secondary and tertiary levelling for commercial purposes as described below. A fuller account will be given in the Geodetic Report, 1926-27.

205. Personnel.—The field strength was 1 Class II officer, 8 Upper Subordinate officers, 21 Lower Subordinate officers and 57 purely temporary levellers, clerks, &c.

Mr. N. R. Mazumdar (Class II) was incharge of the group doing secondary and tertiary levelling for the Haveli Project of the Punjab Irrigation Department. He was assisted by Messrs I. K. Ponnappa and B. P. Rundev (U. S. S.) who did the secondary levelling of the Project in the earlier part of the season, and latterly computations. There were 3 Lower Subordinate Service officers incharge of three tertiary levelling camps with one camp assistant and 12 to 14 levellers in each section.

Mr. D. H. Luxa (Class II), temporarily lend by the Officer in charge, Computing and Tidal Party, with one Lower Subordinate officer as second leveller and two recorders, executed the secondary levelling for the Burma Government.

Mr. K. K. Das (U. S. S.) was incharge of the computations at headquarters with a computer under him.

Mr. S. C. Mukerjee (U. S. S.) with Mr. J. N. Kohli (U. S. S.) as second leveller, and two recorders was employed in secondary levelling for the E. I. Railway, Calcutta Post Trust and the Bengal Government.

206. Secondary Levelling.

For East Indian Railway.—

Ghāziābād-Cawnpore	289 miles.
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For Calcutta Port Trust.—

In Bally	2 miles.
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Dakhineswar-Hastings	11 „
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Hastings-Pujāli	18 „
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For Bengal Government.—

Khulnā-Mādāripur	77 miles.
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Mollāhāt-Barisāl	97 „
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Kachuā-Alipur	62 „
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For Burma Government.—

Thanatpin-Tongyi	26 miles.
Ohne-Thongwa-Ohne	85 „

For Punjab Government (Haveli Project).—

Garh Mahārāja-Dāmāniā	...	...	55 miles.
Dāmāniā-Aharbelā	...	...	37 „
Rangpur-Muzaffargarh	...	...	53 „
Muzaffargarh-Basti Maluk with a branch line to Rohillānwāli	...	...	50 „
Shujābād-Sabuwāli	...	...	22 „
Basti Maluk-Kabirwāla	...	...	62 „
Aharbelā-Multān	...	...	34 „

207. *Tertiary levelling* for the Haveli Project covered an area of 1,905 sq. miles and comprised 1,140 miles of double levelling and 10,587 miles of single levelling. The levellers followed the lines cleared by the rectangulators, instead of clearing their own lines, as they had to do for the Sutlej Valley Project. This change saved some time and expense.

The rectangulation and levelling of this Project were done in the same season. As rectangulation was not sufficiently ahead when the levellers took the field, their progress was checked. For economy, it is desirable that rectangulation should be done a season ahead of levelling.

The cost rates of tertiary levelling, which include 14 per cent for supervision and instrumental charges, work out to Rs. 48·7 per square mile or Rs. 6·3 per linear mile.

Training School, Dehra Dūn.

Officer in charge.—Mr. S. F. Norman.

208. Sixteen probationers were appointed to the Upper Subordinate Service; of these, 14 reported for training on the 22nd November 1926.

After preliminary instructions at Dehra Dūn, the unit took the field on the 8th December 1926 for instruction in planetabling. Detail survey on the scale of 4 and 2 inches to 1 mile was undertaken, and an area of 8 and 16 square miles, respectively, was completed by each pupil, after which the unit returned to Dehra Dūn for instruction in traingulation, traversing and levelling.

During the recess season one Upper Subordinate officer and five surveyors from the several circles were trained in cantonment and large-scale surveys, and a 'refresher' course was given to those officers from the Circles who could be spared.

Shaksgam Valley Exploration.

Officer in charge.—Major K. Mason, M.C., R.E.

209. An expedition was sanctioned by the Government of India towards the end of 1925 to explore and survey the sources of the Shaksgam river and the Aghil range, which lie beyond the Karakoram range. Major Kenneth Mason, M.C., R.E., Survey of India, was placed in charge of the work. His party consisted of Major H. D. Minchinton, M.C., 1st Gurkhas, Major R. C. Clifford, D.S.O., M.C., I.M.S., Captain F. O. Cave, M.C., the Rifle Brigade, and Khan Sahib Afraz Gul Khan, (U. S. S.), Survey of India. Three Gurkha sepoy and one havildar from No. 18 Party, Survey of India, were the only down-country personnel employed.

Supplies and fodder for transport were arranged for in Leh and the Nubra valley; some difficulties were caused on the Himalayan passes by late spring falls of snow. The expedition, taking the Central Asian trade route as far as the Karakoram pass, reached the headwaters of the Yärkand river at the end of June and crossed into unexplored ground at the source of the Shaksgam on 2nd July, with a caravan of about 160 ponies and 24 Lādakhī porters.

The head basin of the Shaksgam was first explored. The valley was found to be blocked by a large glacier which descends from the northern wall of the Karakoram range, in the neighbourhood of the Apsarasas group and Teram Kangri. A fine view was however obtained from the mountains east of the glacier, as far as K² and the Gasherbrum peaks, and the valley beyond the block was surveyed by planetable and Wild photo.-theodolite. There is no doubt that this valley is a continuation of the one ascended by Sir Francis Younghusband from the foot of the Aghil pass in 1889. No useful object would have been gained by forcing the glacier with a small party and merely traversing the ground that could be seen from the stations; and as the ponies were becoming weaker from lack of grass, it was decided to make a new base at the head of a tributary to the Yärkand river, discovered by Major H. Wood, R.E., Survey of India, in 1914.

From this new base, Major Mason took a party across the glaciers at the head, explored and surveyed the barren valleys beyond, and discovered a high plateau, whose existence was previously unsuspected. This plateau was surveyed and a way found westwards to a previously unknown river, which at first was believed to be the middle course of the Shaksgam river; it subsequently turned out to be a large tributary to this river, but the junction could not be reached owing to the amount of water caused by the melting of the snows.

As a result of these explorations about 1,500 square miles of previously unknown country have been surveyed on the half-inch scale, and this area will be increased when the topography plotted in Switzerland by the Wild Stereo-Autograph is included. This area includes the whole head basin of the Shaksgam, its upper sources and tributaries, and its first large feeder glacier; a very large portion of the series of parallel ridges of the Aghil range, whose altitude has for the first time been determined; the head basins of the Yärkand tributaries discovered in 1914 by Major Wood; and the Aghil Depsang plateau. Some very fine views of K², the second highest mountain of the earth, and of the other great peaks have been obtained. Zoological, botanical, and geological collections have been made and have now been worked out by experts. A complete series of cirrus cloud and other meteorological observations were made, and a detailed examination of the extensions of the range axes was carried out. On the return of the expedition, a quarter-inch survey of the country and glaciers between the upper Shyok and Pānāmik in the Nubra valley was made by the Khan Sahib, and photographs were taken with the Wild photo.-theodolite of the lower Nubra. These have now been plotted on the Autograph in Switzerland and it is hoped to bring up to date the existing map of this portion of the trade route. The old 'atlas' map of this district has long been known to be inaccurate.

The whole area explored is extremely barren. Peaks of 21,000 and 22,000 feet are common. The party was for three months almost continuously over an altitude of 16,000 feet, with stations much higher. Grass and fuel were very scanty, and to the lack of grass must be attributed the high mortality among baggage animals. Of 21 ponies bought, ten died from various causes and there were 20 deaths among the hired animals. The health of the party was good on the whole, but a few accidents occurred. The most serious of these was due to a fall of the hillside, which fractured the skull of one of the men. Thanks to Major Clifford, this man completely recovered, and the party broke up fit and well in Srinagar in November.

An account of the expedition was given to the Royal Geographical Society on 24th January, 1927 and published in the *Geographical Journal* for April 1927. The results of the Stereographic Survey Experiments with the Wild instruments were read before the Royal Geographical Society on 9th May, 1927 and were published together with a description of the Autograph in the *Geographical Journal* for October 1927. A full report giving the scientific results, including brief contributions and classifications of the collections by Natural History Experts is

now under preparation and will be published in the "Records of the Survey of India".

Exploration in the Hunza Valley.

210. An expedition led by Mr. C. F. Montagnier, a member of the Alpine Club and Captain C. J. Morris, 3rd Q. A. O. Gurkha Rifles, left Srinagar about the middle of May, with the object of completing the exploration of the gap between the Visser Expedition of 1925 and Major K. Mason's Shaksgam expedition of 1926. Surveyor Torabaz Khan, Survey of India, was deputed to accompany the party.

The party was stopped at Shingshāl about the middle of July and political considerations prevented them from crossing the pass into the Shaksgam Valley; but surveys were completed of the hitherto unsurveyed and difficult valley of the Ghujerāb; of the previously unsurveyed Yashkuk Glacier; and of the indifferently surveyed Chapursān Valley. It was also intended to survey the Toltar Glacier west of the Batūra Glacier, but time was too short.

An area of about 300 square miles on the scale of $\frac{3}{8}$ inch to 1 mile was surveyed in the Ghujerāb Valley, falling in sheets 42 L & P, and about 660 square miles in the Chapursān Valley and Yashkuk Glacier in sheet 42 L. The country surveyed is probably as difficult as any in the world.

Both Mr. Montagnier and Captain Morris have referred in high terms of appreciation to the industry and energy displayed by Torabaz Khan, by whom the whole of this survey was carried out.

APPENDIX I.

ANNUAL REPORTS OF THE SURVEY OF INDIA.

1. After considerable vicissitudes during the past few years our Annual Reports have at last reached a stage where we may usefully review the history of the problem and the conditions leading to the present solution.

2. Up to 1877 three separate Annual Reports were published by the Revenue, Topographical and Trigonometrical Branches. From 1877 to 1900 these were combined in one large volume giving very full reports on the work of all units. Since 1900 the General Report has been published in a condensed form and has been supplemented by a second volume, which consisted up to 1909 of selected "Extracts from Narrative Reports", after which this supplementary publication took the form of an annual volume of the "Records of the Survey of India", which gave a full narrative report of the work of all units. Under this system, which continued from 1909 to 1922, much information was published twice over condensed in the General Report and elaborated in the "Records" Volumes, and a large number of identical Index maps appeared in both publications. Also owing to the stress laid on topographical surveys, all other work was relegated to separate parts of the volumes, so that one did not get a complete consecutive statement of the whole work of each unit.

3. The publication of the annual "Records" Volumes was stopped after 1922, owing to retrenchment and other difficulties; material for them was however prepared in the same form as before, by all units, and was bound up in the manuscript for all Circles, pending a decision as to some more satisfactory solution. These manuscript records were very unsatisfactory and could only be regarded as a temporary makeshift; while the published General Reports became balder and more condensed than ever, and were reduced to octavo size, in accordance with the new policy of Government in regard to official publications.

4. First attempts at the present form of publication were adopted for the Reports of 1924-25 and 1925-26; but these were still supplemented by the makeshift of binding together full manuscript reports based on the old system and not prepared in a durable form. The present year is thus the first in which we have been able to establish a complete

solution to replace the system which terminated in 1922 with the publication of the last of the Annual "Records" Volumes.

5. The new system greatly reduces the delays of publication by grouping the reports into 3 separate volumes for which different officers are responsible, as follows :—

(a) *The Map Publication and Office Work Report* is prepared by the Director, Map Publication and corresponds with the financial year terminating on the 31st March. It can therefore be printed at Calcutta before the material for the General Report is received. It includes in a compact and accessible form all statistics of drawing and publication offices, with Index maps showing progress of the various series of maps on different scales published by the Department.

(b) *The Geodetic Report* is prepared by the Director, Geodetic Branch for the survey year ending 30th September. It includes full reports of all scientific work for the use of specialists, with appropriate Index maps. It is printed independently at Dehra Dūn, so that other Reports are no longer delayed by the laborious proof corrections and other sources of delay inevitable in scientific publications.

A combined volume is being published for the years 1922-23, to fill the hiatus arising from the cessation of the Annual Records Volume since 1922: Annual volumes are under publication for subsequent years, and it is hoped to have the series complete and up to date by next year.

(c) *The General Report* includes brief abstracts of the above two Reports, sufficient for general purposes. It is prepared by the Assistant Surveyor General at Calcutta and corresponds with the survey year to 30th September, so that it will appear later than the Map Publication Report and need not repeat the Index maps showing progress of map publication; nor does it include any of the Index maps of geodetic work which appear in the Geodetic Report. We are thus able to free this General Report from the bewildering variety of Indexes with which it used to be burdened, and confine it to one single Index map showing the progress of topographical surveys since 1905, which is the prime work of the Department.

On the other hand the General Report now gives a fuller account of the work of all field survey operations, in place of the bald summaries which used to be supplemented by fuller reports in the Annual "Records" Volumes. Also the whole work of each unit is given in a single compact statement, instead of being scattered over various Parts of the Report according to the nature of work. The object of this previous separation of the work into Parts is now better met by Abstract I, which enables anyone interested in a particular form of work, *e.g.*, forest surveys, or in a particular area, to look up all relevant parts of the Report without difficulty.

6. *Supplements.* The Map Publication and Geodetic Reports are complete and need no Supplement; but the General Report does not give minor statistics regarding surveys, which are needed for departmental reference, and also its Index map is on too small a scale to show exact details of survey operations. Each survey unit therefore now prepares a "Technical Supplement" giving minor statistics of departmental interest, and also "Detail Index maps" showing exactly the work of each year on

all scales of survey. A few copies of these are prepared in durable form, and are bound *in manuscript* for future reference in the Department. By these means all essential needs are being met with much economy of labour and a very great increase in the promptitude of publication. Thus the exclusion from the General Report of minor details of all kinds makes it possible to get most of the material to press in the summer, so as to have the whole of it nearly ready for publication by the close of the survey year on 30th September; it can thus be bound and issued about a year earlier than was possible under previous conditions.

7. The survey reports of the General Report will also be supplemented from time to time by occasional volumes of the "Records of the Survey of India" which will give a full account of special survey operations of exceptional interest.

8. *Minor improvements* of various kinds have also been introduced into all the Reports. Perhaps the most valuable of these is the attempt to show future work on the Index maps; thus the General Report Index indicates the probable *locale* of survey operations for the coming field season, while the Map Publication indexes show maps in hand and likely to be published in the near future, in addition to those already published up to the date of completion of the Report. This procedure, combined with prompter publication of the Reports, will give all current information almost up to the date when the next volumes will become available.

9. These changes have been effected during a period of considerable difficulty, and many imperfections still remain which can only be set right by the light of further experience of the new system.

APPENDIX II.

THE FIRST SURVEY OF NEPĀL, 1924-1927.

1. In 1924 His Highness Maharaja Sir Chandra Shamsheer Jung Bahadur, Rana G.C.B., G.C.S.I., G.C.M.G., G.C.V.O., D.C.L., Honorary General in the British Army and Colonel of the 4th Gurkha Rifles, Prime Minister and Marshal Supreme Commander-in-Chief of Nepāl, asked for the co-operation of Indian Surveyors of the Survey of India in preparing complete modern maps of the whole of Nepāl. This enlightened act has resulted in one of the greatest single contributions to Himalayan Geography which has ever been made, by giving us for the first time accurate knowledge of the drainage and structure of 55,000 square miles of country (an area approximately equal to that of England and Wales), extending over some of the greatest mountains of the world, and including the highest known peak, Mount Everest, which is over 29,000 feet above sea level. This work constitutes such a valuable addition to geographical knowledge that a skeleton map of Nepāl is published as a frontispiece to the present General Report in order to furnish geographers of all countries with the main outlines of the country, pending the preparation of maps on larger scales*.

2. A complete contoured map on the scale of 8 miles to 1 inch was required, but the field work was carried out on the more convenient scale of 4 miles to 1 inch. A special 8-mile map is now being prepared in three sheets, after which the new information will be incorporated in revised editions of the Standard degree sheets on the scale of $\frac{1}{4}$ inch to 1 mile.

3. Two Nepālese officers, Lt.-Colonel Ganesh Bahadur Chattri and Captain Ganj Bahadur Karki, were placed in control of the survey, and their ability and untiring efforts in organising transport and supplies in a most difficult country were the main essentials in the successful accomplishment of the whole work.

4. *Season 1924-25.* Work commenced at Kātmāndu in November 1924, when Messrs Jugāl Behari Lal and Lalbir Singh of the Upper Subordinate Service of the Survey of India, with one surveyor and one computer, also of the Survey of India, reported themselves to the Nepālese officers in charge.

*The Director, Geodetic Branch, Survey of India, Dehra Dūn, will supply spare copies of this skeleton map to any geographers or scientists who may require it.

The small scale of survey and the desirability of starting the plane-tableing without delay, combined with the difficulty of carrying triangulation through the Tarai country, made it unnecessary to follow the rigorous methods of triangulation normally carried out inside India. Direct connection with the Indian triangulation was therefore dispensed with during the first season and the position of Kaulia (a station near Kātmāndu fixed by Captain H. Wood, R.E., in 1903 by theodolite resection from distant peaks) was accepted as correct. A base of 3,600 feet was measured at Kātmāndu, and from this Mr. Jugal Behari Lal carried out triangulation over an area of 8,000 square miles. Mr. Lalbir Singh and one surveyor meanwhile completed the survey of 7,925 square miles on the $\frac{1}{4}$ -inch scale over the same area.

5. *Season 1925-26.* The strength of the detachment was raised to fourteen by the addition of ten more surveyors. Mr. Jugal Behari Lal remained in charge, and in addition to supervising the surveyors he extended the triangulation with the assistance of Mr. Lalbir Singh.

This season Mr. Jugal Behari Lal based his triangulation on existing Indian triangulation on the Kumaun-Nepāl border, and proceeded in a south-easterly direction as far as Bānjkot (Lat. $28^{\circ} 58'$, Long. $81^{\circ} 14'$), where he connected with a similar series executed by Mr. Lalbir Singh and emanating from old triangulation on the southern border of Nepāl in longitude $84^{\circ} 20'$. An area of 19,250 square miles was adequately covered with triangulated points.

The season's outturn of topography amounted to 33,045 square miles. This was inspected as far as possible by Messrs Jugal Behari Lal and Lalbir Singh, ably assisted by the two Nepālese officers previously mentioned. In addition to the data provided by the new triangulation, use was made of peaks fixed from old triangulation in the plains of India and from the Darjeeling triangulation to the east. The latter, especially, enabled a large area to be surveyed without any fresh triangulation.

6. *Season 1926-27.* The detachment remained at the same strength, with personnel unchanged, and completed the topography, covering an area of 14,025 square miles. Field work was finally closed in March 1927.

7. *Results.* The total area surveyed, 55,000 square miles, covers the whole of Nepāl up to the borders of previous Indian Surveys. Three small areas had to be omitted (*vide* frontispiece). The first is a small gap (60 square miles) north of Manang Bhot near the main

axis of the Himālaya, where work was stopped by continuous snow storms; the second (150 square miles), north of Jagdol Lekh, was only roughly sketched on account of bad weather; the third, near Rasua Garhi on the Tibet border, was invisible from the Nepāl side, and could only have been surveyed by crossing the border into Tibet. The Nepālese Government proposes to have these blanks filled in as soon as possible by its own surveyors.

8. *The country* surveyed presents great diversities of climate and relief. On the south it is bordered by a low-lying tract of Tarai, covered with forest and very malarious. The centre of the country consists of steep hills 5,000 to 10,000 feet high, largely forest covered and intersected by deep valleys. It is bordered on the north by the main axis of the Himālaya, a region of high cliffs and perpetual snow, where survey is made additionally difficult by mist and cloud.

9. *Accuracy of the Survey.* Considering that the triangulation had to be carried out concurrently with the topography in the first two seasons, and the many difficulties presented by the country, the resulting surveys show evidence of a very satisfactory degree of accuracy. It is believed to contain very few inaccuracies which will be appreciable on the scale of 8 miles to the inch. None of the stations of the triangulation are likely to be as much as 100 feet wrong in position or 20 feet in height. The junction of two series at Bānjkot (para. 5) revealed closing errors of 0".51 in latitude, 0".87 in longitude, and 15 feet in height. Apart from a few cases of doubtful identification, fixings of distant peaks whose positions were previously known agree within 250 feet in position and 50 feet in height. The agreement is generally much closer. It is believed that the maximum errors of topography can hardly exceed half a mile anywhere, and that the average error of planetable fixings throughout the work should be well within one quarter of a mile, or about one thirtieth of an inch on the 8-mile scale.

The successful completion of this survey in the short time of three years, in spite of the difficulties of climate and topography, is a notable achievement and reflects great credit on all the officers and surveyors concerned.

10. *Nomenclature of the peaks.* The Nepālese only give specific names to a few snow-covered peaks of remarkable aspect, but each group of snowy peaks is called a Himāl* or "Abode of snow", and receives a

* The Hindi contraction *Himāl* is generally used in Nepāl and the Eastern Himālayas in place of the Sanscrit *Himālaya* used further west.

name. Thus *Mount Everest* dominates the *Māhā Langur Himāl*; *Kinchin-junga*, the *Singālilā Himāl*; *Dhaulāgiri*, a *Himāl* of the same name; *Gaurī Sankar*, the *Rolwāling Himāl*; and *Api*, the *Viyās Rishi Himāl*. Mount Everest itself, whose steep southern face carries little snow, is inconspicuous from the south and has received no Nepālese name. It has recently been suggested that the Tibetans give Mount Everest the name of Chomolomo, but Lt.-Colonel Ganesh Bahādur, of Nepāl, considers that this name is used for the whole northern side of the *Māhā Langur Himāl*, and that it is not the name of the peak.

In view of Captain Wood's work in 1903 and the full summary of the situation published in 1904 in "Nature", Voloume LXXI, pages 42-46, it is surprising that some European geographers still persist in giving the name *Gaurī Sankar* to Mount Everest. By enquiry in the immediate neighbourhood, the name of *Gaurī Sankar* was definitely found to apply to the *twin peaks* (23,440 feet) situated over 30 miles West of Mount Everest, as identified by Captain H. Wood in 1903. The local inhabitants frequently use the alternative name of *Gaurā Parbatta*. Either name implies the idea of *Shiva and his wife*, and is suitable to these twin peaks but would be quite inapplicable to the isolated pyramid forming the summit of Mount Everest.

NOTE

INDEXES showing **MAPS PUBLISHED** to date on various scales by the Survey of India are bound with the annual Map Publication Report.

INDEXES illustrating Geodetic Operations are bound with the annual Geodetic Report.

MODERN TOPOGRAPHICAL SURVEYS AND COMPILATION

on scales ranging from 4 inches to 1 mile to $\frac{1}{8}$ inch to 1 mile.

Survey & Compilation
from 4" to 1 mile to $\frac{1}{8}$ " to 1 mile scales.

SURVEY OF INDIA

SURVEY CIRCLES

(boundaries shown in blue)
Director Frontier Circle, Simla
Central " Mussoorie
Southern " Bangalore
Eastern " Shillong
Burma " Maymye
Also Director Geologic Branch Dehra Dun
Map Publication, Calcutta
Assistant Surveyor General, Calcutta

N. B. The index shows all topographical work brought on to the true longitude since 1905. Previous topographical work, in the blank areas was about two miles out of position, being based on the old longitude of 1815.

SYSTEM OF NUMBERING SHEETS.

THE $\frac{1}{4}$ SERIES forms the basis of numbering for sheets on all scales. It consists of sheets 4" x 4" on the scale of 1:1,000,000, whose numbers are shown on the Index thus:.....

QUARTER-INCH SHEETS—Each $\frac{1}{4}$ sheet is divided into 16 sheets of scale quarter-inch to one mile, lettered A-P as shown on the Index. The name of each quarter-inch sheet is therefore written thus: 55.K

HALF-INCH SHEETS—Each $\frac{1}{4}$ inch sheet is divided into four half-inch sheets, named respectively N.W., N.E., S.W., S.E. The name of a half-inch sheet thus takes the form:..... 55.K.N.E.

ONE-INCH SHEETS—Each $\frac{1}{4}$ inch sheet is divided into 16 one-inch sheets, numbered from 1 to 16 as here shown. The name of a one-inch sheet thus takes the form:..... 55.K.12

FOR THE YEAR 1927.

REFERENCES.

MODERN SURVEYS (since 1905).

Scale 1 inch to 1 mile, and over

" about $\frac{1}{2}$ inch to 1 mile

" $\frac{1}{4}$ inch to 1 mile, and less

MODERN COMPILATION (since 1905).

Scale 1 inch to 1 mile, and over

" about $\frac{1}{2}$ inch to 1 mile

" $\frac{1}{4}$ inch to 1 mile, and less

CURRENT SURVEYS are further distinguished by marks as follows.
Surveyed last season 1926-27
Proposed for survey in 1927-28
(with red initials or numbers to indicate the unit concerned)

Scale 1:12,000,000

Miles 100 0 100 200 300 400 500 600 700 800 900 Miles

Published under the orders of Colonel Commandant E.A. Tandy, R.E., Surveyor General of India 1927.

SURVEY OF INDIA
GENERAL REPORT
1926 TO 1927.